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Severn Sound

Remedial Action Plan/Plan d'Assainissement

SEVERN SOUND REMEDIAL ACTION PLAN

STAGE 2 REPORT

A STRATEGY FOR RESTORING THE SEVERN SOUND ECOSYSTEM AND DELISTING SEVERN SOUND AS AN AREA OF CONCERN

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Severn Sound remedial action plan, stage 2 report : a strategy for restoring the Severn Sound ecosystem and delisting Severn

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SEVERN SOUND REMEDIAL ACTION PLAN
STAGE 2 REPORT

A STRATEGY FOR RESTORING THE SEVERN SOUND ECOSYSTEM AND DELISTING SEVERN SOUND AS AN AREA OF CONCERN

PREPARED BY THE SEVERN SOUND RAP TEAM
IN CONSULTATION WITH THE PUBLIC ADVISORY COMMITTEE

ENVIRONMENT CANADA

ONTARIO MINISTRY OF ENVIRONMENT AND ENERGY

ONTARIO MINISTRY OF NATURAL RESOURCES

ONTARIO MINISTRY OF AGRICULTURE AND FOOD

DEPARTMENT OF FISHERIES AND OCEANS

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"UNLESS Someone like you
cares a whole awful lot,
nothing is going to get better.
It's not."

from The Lorax by Dr. Seuss
1971, Random House Inc., New York

FOREWORD

The Ontario Ministry of Environment and Energy and Environment Canada are working with other federal and provincial agencies and local stakeholders in the Severn Sound area to develop a Remedial Action Plan (RAP). The purpose of the RAP is to restore and preserve the beneficial uses of Severn Sound for the present and the future.

In accordance with the International Great Lakes Water Quality Agreement (GLWQA), the first stage of the RAP, that of describing Environmental Conditions and Problem Definition (Severn Sound RAP, 1988) was submitted to the International Joint Commission (IJC) in February, 1989. In June, 1991 the IJC informed the Canadian Government that the Severn Sound RAP has met the requirements of a Stage 1 RAP under the terms of Annex 2 of the GLWQA (1987).

The following document was prepared as required for Stage 2 of the RAP process and includes:

- the steps taken to consult and work with the public during the development of the RAP
- a review of the recommended remedial actions in progress and under consideration to restore the environmental quality of the Sound
- the surveillance and monitoring plan to monitor progress toward achieving the use goals and targets of the plan
- a proposed implementation plan for the RAP

The document also contains a summary of environmental conditions of Severn Sound with findings of studies conducted since the Stage 1 report was prepared in 1987.

Full discussion of the Stage 2 RAP will be carried out as part of the RAP Public Involvement Program. This discussion will be aimed at:

- establishing commitments from stakeholders to implement the remedial action plan
- resolving any conflicts between stakeholders
- identifying any barriers to implementation
- identifying additional information requirements

The RAP will also be submitted to the Federal and Provincial Governments for a statement of their commitment to implementation of the plan. Finally, the completed Stage 2 will be submitted to the IJC as fulfilment of the Stage 2 requirements of Annex 2 of the GLWQA.

The next major stage in the RAP process following acceptance is implementation of this plan. Commitments to the remedial actions will require various forms of agreements and funding arrangements. Over the summer of 1993 a major effort will be made to obtain implementation agreements and, as before, carry out actions as soon as the technical information and funding responsibility are clear.

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J. Leslie, DFO, Burlington	-	larval fish data
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K. Suns, MOEE, Rexdale	-	juvenile fish analysis
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Many thanks to Bob Whittam and staff of the Wye Marsh Wildlife Centre who act as facilitator for the RAP.

The following members of the Severn Sound Public Advisory Committee dedicated many hours of their own time, contributing their questions, ideas and comments to the development of the RAP.

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SUMMARY

RAP Development

Severn Sound is a group of bays in southeast Georgian Bay. The Sound was listed as an area of concern by the International Joint Commission (IJC) because of problems stemming from nutrient enrichment. A remedial action plan has been developed by the provincial and federal governments in order to restore environmental quality. The goals of the plan are:

1. to improve water quality in the Sound and
2. to maintain a healthy ecosystem in Severn Sound.

Specific Water Use Goals for Severn Sound include:

1. The water should be swimmable virtually everywhere in Severn Sound.
2. The fish and water-based wildlife habitats in Severn Sound should be protected to maintain their healthy, naturally reproducing communities.
3. The fish from Severn Sound should be edible.

Environmental Status (Section 2)

Nuisance algae growths have adversely influenced Severn Sound since the 1960's. They lead to impairment of recreational uses such as swimming and poor oxygen conditions in the bottom waters that could adversely affect fish. Despite a long-term trend (1973-1991) of declining total phosphorus concentration, a key nutrient controlling the growth of algae, conditions are worse in recent years. Nuisance algae densities have not changed since the early 1970's. Water clarity as indicated by Secchi disc has decreased in many areas of the Sound.

The key nutrient controlling the growth of algae in the Severn Sound is phosphorus. There is a direct relationship between open water total phosphorus concentration and the average density of algae. Several controllable sources of phosphorus have been identified and a strategy for reducing these sources forms an important part of this plan. A healthy, balanced aquatic community is also important in controlling algae growth. Efforts to improve the numbers of predator fish, such as walleye, should have a balancing influence on the food chain and lead to an indirect "top down" control of algae densities by improving the density of water fleas that eat the algae.

Fish populations have changed in the Severn Sound since the 1970's and may reflect more subtle and serious effects of nutrient enrichment. The walleye, a prized sport fish and sensitive predator species, declined drastically in number in the late 1970's. The walleye population has shown a promising response to stocking efforts. However, numbers are still low. The sport fish catch of walleye has not increased since the initial decline.

In addition to nutrient enrichment, historical destruction of habitat, especially in the tributaries and nearshore coastal waters, may have adversely affected the Severn Sound fish community. A survey of available habitat and studies of what elements of physical habitat benefit the fish community are under way. In the interim, a classification of shoreline habitat has been made in order to guide the review of development proposals and avoid destroying those areas known to be essential such as wetlands and identified spawning areas. The classification also identifies areas where habitat should be created or enhanced to improve productive potential for fish.

Potential trace contaminant sources to the Sound have been investigated using a variety of sampling techniques. Some trace metals (e.g. chromium) show potential to transfer from the sediments into aquatic life in muddy areas of bays on the south side of the Sound. However, no toxicity of these sediments to sensitive test organisms was noted. No apparent active source of mercury exists within Severn Sound. Mercury contamination of large (old) sport fish persists. The mercury probably originates from regional geological or atmospheric sources that are lake wide rather than localized. Based on tissue analysis of organisms that reflect potential for localized sources of organochlorine contaminants, such as spottail shiners or passerine birds eggs, organochlorine contaminants are relatively low or undetectable and therefore active local sources are not contributing to the Severn Sound.

Persistent trace contaminant levels in Severn Sound are generally low and do not warrant remedial action other than monitoring and control of sources before problems arise in the Sound. Trace contaminants are still of concern as many are in use in the area and could be accidentally or unwittingly discharged to the Sound. A strategy of preventing contamination is recommended as part of this plan.

Delisting Severn Sound as an Area of Concern (Section 3)

The present environmental conditions were compared with the Severn Sound RAP Water Use Goals and the use impairments listed in Annex 2 of the Great Lakes Water Quality Agreement (GLWQA). Specific RAP objectives were selected that will indicate when remedial actions have achieved environmental improvements and when Severn Sound can be "delisted" as an Area of Concern (Table A-1 and A-2). In Severn Sound, several objectives, including these related to the two main problems of eutrophication and changes in fish community, have not been achieved as yet. Specific objectives and methods for measuring progress towards restoration are still under development for the assessment of uses (for example the assessment of fish habitat).

Table A-1 Objectives to be achieved in order to permit delisting of Severn Sound		
USE IMPAIRMENT		**PROPOSED SEVERN SOUND DELISTING OBJECTIVES**
(i)	Restriction on fish and wildlife consumption.	To have no restrictions on consumption of fish and wildlife from the Severn Sound attributable to local contaminant sources
(ii)	Tainting of fish and wildlife flavour.	To continue to have no tainting of fish and wildlife
(iii)	Degraded fish and wildlife populations.	<u>Fish</u> 1. To protect and rehabilitat fish and wildlife habitat. 2. To restore a balanced, self-sustaining fish community by restoring top-level predators including walleye, northern pike, large and smallmouth bass and muskellunge to levels similar to the early 1970's with these species forming at least 20-30% of the total predator catch, and walleye forming at least 10%. 3. To maintain a natural, diverse fish community, to discourage the introduction of exotic species and to prevent the extinction of native or desirable species. <u>Colonial waterbirds:</u> 4. To maintain a self sustaining, diverse community of colonial waterbirds which currently nest in and near the Sound. <u>Other Wildlife (including waterfowl)</u> 5. As part of the Matchedash Bay project of the North American Waterfowl Management Plan (NAWMP) to produce 2450 waterfowl including 880 Mallard, 210 Black Duck and 1360 other waterfowl of various species (NAWCC, 1991). 6. Wildlife populations will be maintained at levels sufficient to provide recreational and economic benefits, ensure environmental quality, ecosystem integrity and ensure public safety while preventing the extinction of native or desirable species. 7. To re-introduce a self sustained population of Trumpeter Swans in the Severn Sound area. 8. To maintain no significant toxicity from water column or sediment contaminants in fish and wildlife bioassays.

Table A-1 Objectives to be achieved in order to permit delisting of Severn Sound		
USE IMPAIRMENT		**PROPOSED SEVERN SOUND DELISTING OBJECTIVES**
(iv)	Fish tumours and other deformities.	1. To maintain the currently low incidence of tumours and other deformities.
(v)	Bird or animal deformities or reproductive problems.	2. To maintain the currently low incidence of deformities and reproductive problems typical of reference areas unaffected by toxic chemical contamination.
(vi)	Degradation of benthos	1. To reach appropriate benthic community targets and ecosystem objectives for Severn Sound. 2. For the interim, to have benthos characteristic of mesotrophic conditions throughout Severn Sound (Edwards and Ryder, 1990). (a) To maintain and enhance presence of the mayfly *Hexagenia* as an indicator of ecosystem health. (b) To have a sludge worm density, including *Limnodrilus hoffmeisteri*, less than 3,000/m^2 in all locations. 3. To maintain the absence of toxic effects on benthos attributable to trace metals or organics in sediments throughout Severn Sound.
(vii)	Restrictions on dredging activities.	To meet biological and chemical guidelines for sediment quality and eliminate restrictions on dredging or disposal activities attributable to polluted sediments.
(viii)	Eutrophication	See Table A-2 for controllable phosphorus source and concentration targets.
(ix)	Restrictions on drinking water	To maintain surface water quality in Severn Sound so that raw water following standard treatment procedures (coagulation, settling, filtration) meets the Provinical Drinking Water Objectives.
(x)	Beach closings.	To meet current Provinical objectives for water clarity, pH and bacteria indicator (E.Coli): Geometric mean E. Coli density: <100 organisms/100ml Secchi disc visibility: >1.2m Algae densities: <5ug/L (mean ice-free period as chlorophyll)
(xi)	Degradation of aesthetics.	To meet current ministry objectives for aesthetics: Algae densities <5ug/L (mean ice-free period as chlorophyll)
(xii)	Added cost to agriculture or industry.	To have no additional cost for treatment of water by the users for agriculture or industry due to deterioration from contaminant sources in Severn Sound.

Table A-1 Objectives to be achieved in order to permit delisting of Severn Sound		
USE IMPAIRMENT		**PROPOSED SEVERN SOUND DELISTING OBJECTIVES**
(xiii)	Degradation of phytoplankton and zooplankton populations.	To ensure phytoplankton species and biovolume are representative of mesotrophic conditions and to have a balanced zooplankton community with more *Daphnia*.
(xiv)	Loss of fish and wildlife habitat.	1. To implement the Severn Sound Fish Habitat Management Plan, the Provincial Wetland Policy and other policies to enhance and protect fish and wildlife habitat. 2. To encourage the restoration and creation of fish habitat in target areas by proponents of new shoreline development. 3. To develop plans for rehabilitation or development of new coastal wetland areas as opportunities arise. 4. As part of the Matchedash Bay project, to: a) secure and manage 1715 ha of wildlife habitat b) restore and develop 427 ha of habitat for waterfowl and other wetland dependant wildlife c) maintain and enhance 442 ha of habitat for staging waterfowl. 5. To rehabilitate tributaries and riparian areas for fish and wildlife habitats. 6. To maintain existing colonial waterbird nesting sites within and near Severn Sound. 7. To maintain and increase Osprey nesting sites within Severn Sound.

TABLE A-2

OBJECTIVES FOR CONTROLLABLE PHOSPHORUS SOURCES
AND EXPECTED CONDITIONS

	PENETANG BAY		STURGEON BAY		PORT SEVERN		OPEN SEVERN SOUND	
SOURCE	Conc. (mg/L)	Load (kg/yr)	Conc. (mg/L)	Load (kg/yr)	Conc. (mg/L)	Load (kg/yr)	Conc. (mg/L)	Load (kg/yr)
WPCP Effluents*	<0.10	270	<0.15	259	<0.3		<0.3	
Bypassing / CSO		Virtually Eliminated		Virtually Eliminated		Virtually Eliminated		Virtually Eliminated
Storm Water+		decrease by 20%*		decrease by 20%*		decrease by 20%*		decrease by 20%*
Watershed+	<0.3	decrease by 20%*	<0.03	decrease by 20%*	<0.03	decrease by 20%*	<0.03	decrease by 20%*
Shoreline	Replace faulty or substandard systems (20% of systems), establish phosphorus removal efficiency target.							
EXPECTED OPEN WATER QUALITY								
[TP] (ug/L)	<20	1000 Kg/yr	<15	6800 Kg/yr	<15		<15	47500 Kg/yr
[Chl. a] (ug/L)	<7		<5		<5		<5	
SDV (m)	>2		to bottom		>3		>3	
Aquatic Plant‡	increase 30%		no change		no change		no change	
Min. D.O. (mg/L)	>5		>5		>5		>5	

* Sewage plants include: Main St. WPCP and Fox St. WPCP (Penetang Bay); Victoria Harbour WPCP (Sturgeon Bay); Coldwater Sewage Plant (Port Severn via Coldwater River and Matchedash Bay) and; Midland Sewage Plant, Port McNicoll Sewage Plant, Elmvale Lagoon (via Wye River) and Penetanguishene Mental Health Centre WPCP (Open Severn Sound).

+ Stream and storm water loadings are variable from year to year. The percentage reduction is based on the estimated effect of best management practice. The Wye River is expected to have a greater load reduction for urban and watershed loads. Watershed load reduction targets are interim.

‡ Based on expected changes in secchi disc visibility

WPCP = Water Pollution Control Plant
CSO = combined sewage overflow
[TP] = total phosphorus concentration
[chl a] = chlorophyll a concentration
SDV = secchi disc visibility
Min D.O. = minimum dissolved oxygen concentration

Recommended Remedial Actions (Section 4)

Nine areas of remedial actions are recommended for Severn Sound (see summary list below). The remedial actions fall into four basic groupings:

A. Those dealing with the strategy to control phosphorus (1-6);
B. Those dealing with the protection and enhancement of fish and wildlife populations and habitat (7);
C. Those dealing with preventing contamination (8); and
D. Actions to incorporate the RAP into municipal plans and development review procedures (9).

Table B provides the priorities for these remedial actions based on three levels of preparedness to implement the actions: #1) those for which implementation action is clear and can proceed; #2) those where action will be preceded by short-term study of technology and cost effectiveness prior to implementation; and #3) those identified as requiring longer-term study to understand cause and effect of remedial actions and additional consultation prior to implementation. Also provided are the implementation responsibilities.

SUMMARY LIST OF RECOMMENDED REMEDIAL ACTIONS

1. Improve Sewage Plant Efficiency

    a. Optimize existing equipment and treatment
    b. Provide additional treatment where needed
    c. Improve outfall dispersion
    d. Consolidate plants to improve treatment and discharge location
    e. Develop sludge storage facilities to eliminate spreading of sludge on frozen or saturated land

2. Upgrade Private Sewage Systems

    a. Replace faulty or substandard systems
    b. Research efficiency of conventional systems on variable soils

3. Reduce Stormwater Supply

    a. Eliminate bypass from sewage pumping stations and combine sewer overflows
    b. Retain and treat stormwater runoff from existing catchments
    c. Plan new development to include stormwater retention and treatment during and after construction
    d. Restrict clearing of land prior to construction
    e. Develop municipal stormwater plans in cooperation with provincial agencies to integrate stormwater management throughout the watershed

4. Reduce Agricultural Sources

    a. Manage runoff from manure storage and barnyards
    b. Eliminate manure spreading on frozen or saturated land
    c. Eliminate sewage sludge spreading on frozen or saturated land
    d. Eliminate the spreading of septage
    e. Treat milkhouse waste
    f. Restrict livestock access to water courses
    g. Encourage conservation tillage, crop rotation and other erosion control practices

5. Reduce Sources of Erosion

    a. Stabilize banks and plant vegetation buffers along water courses
    b. Control erosion during and after road construction and maintenance
    c. Restrict clearing of land prior to and during construction

6. Reduce supply from Marine Activities

   a. Enforce pleasure boat black water legislation
   b. Encourage onboard storage of pleasure boat grey water
   c. Designate one agency to coordinate the review of all marine construction proposals
   d. Review marine construction proposals under the Interim Fish Habitat Management Plan*
   e. Stabilize banks and plant vegetation buffers along shorelines

7. Protect and Improve Fish and Wildlife Populations

   a. Preserve wetlands and other unique and valuable habitat preservation initiatives in proposal review and land use controls
   b. Create productive fish and wildlife habitats in shoreline and marine development
   c. Endorse and implement the Interim Fish Habitat Management Plan*
   d. Rehabilitate fish habitat and buffer vegetation of Severn Sound tributaries
   e. Stock fingerling walleye to restore an abundance of larger predator fish

8. Prevent Contamination

   a. Implement the Ministry of the Environment and Energy MISA** program, especially in the municipal sector
   b. Encourage water conservation in private homes and industry
   c. Encourage the use of safe alternatives to cleaning products containing phosphorus
   d. Encourage industry and consumers to phase out the production, use and disposal of contaminating substances
   e. Control sources of bacteria through:
      . i. a Cottage Pollution Control Survey
      . ii. a boating inspection program
      . iii. an urban stormwater retention and treatment strategy
      . iv. control of farm sources
   f. Monitor to detect any new sources of contaminants and to track declines in contaminant levels.

9. Plan Input and Review

a. Create Model Official Plan amendments with RAP objectives for municipalities
b. Develop Storm Water Management Plans for each municipality
c. Develop Farm Plans incorporating RAP objectives through the Ministry of Agriculture and Food
d. Review marine construction proposals under the Interim Fish Habitat Management Plan*

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* The Interim Severn Sound Fish Habitat Management Plan is an agreement by the Federal Department of Fisheries and Oceans, the Ontario Ministry of Natural Resources and the local municipalities to ensure no net loss of fish habitat.

** The Municipal/Industrial Strategy for Abatement (MISA) is a major Ontario initiative to reduce water pollution from industrial and municipal dischargers. The ultimate goal is the virtual elimination of persistent toxic contaminants from all discharges in Ontario waterways.

Table B: Severn Sound RAP
Implementation Responsibilities and Priorities

Remedial Action	Priority	Responsibility (lead agency in bold)
1. SEWAGE PLANTS		
a. optimization	#1	**Municipality**, MOEE, Env. Can.
b. upgrades	#1	**Munic.**, MOEE, Env. Can. (technology)
c. outfalls	#2	**Munic.**, MOEE, Env. Can. (technology)
d. consolidate	#3	**Munic.**, MOEE, Env. Can. (technology)
e. sludge storage	#2	**Munic.**, MOEE, Contractors
2. PRIVATE SEWAGE		
a. replace	#1	**Shoreland owner**, MOEE, District Health Unit
b. removal efficiency	#3	**MOEE**
3. STORMWATER		
a. bypass/CSOs	#1	**Munic.**, MOEE
b. urban stormwater	#2	**Munic.**, MOEE, MNR, Env. Can. (technology)
c. retention/treatment	#2	**Munic.**, MOEE, MNR
d. clearing of land	#1	**Munic.**, MNR
e. master plan	#3	**Munic.**, MOEE, MNR
4. AGRICULTURE		
a. manure storage	#1	**Landowner**, MOEE, OMAF
b. manure spreading	#2	**Landowner**, MOEE, OMAF, Munic.
c. sludge spreading	#2	**Landowner**, MOEE, Contractors, Health Unit
d. septage spreading	#2	**Landowner**, MOEE, Contractors, Health Unit
5. EROSION		
a. stabilize banks	#1	**MNR**, Landowners
b. road construction	#1	**MTO**, Munic., MNR, MOEE
c. clearing of land	#1	**Munic.**, MOEE, MNR
6. MARINE		
a. enforce black water legislation	#1	**MOEE**
b. encourage grey water storage	#2	**MOEE**
c. lead agency for review	#2	**MNR**, DFO, Transp. Can., Munic.
d. review to include FHMP	#1	**MNR**, DFO, Munic.
e. stabilize coast	#2	**MNR**, DFO

Remedial Action	Priority	Responsibility (lead agency in bold)
7. FISH & WILDLIFE POPULATIONS		
a. preserve wetlands	#1	**MNR**, DFO, Conservation Groups, Munic.,
b. create coastal habitat	#2	**MNR**, DFO, Munic. or "Landowner"
c. FHMP	#1	**MNR**, DFO, Munic.
d. rehabilitate tributary habitat	#1	**Landowner**, MNR, MOEE, Env. Can.
e. stock walleye	#1	**Conservation Groups**, MNR
8. CONTAMINATION		
a. implement MISA	#3	**MOEE**, Munic.
b. conserve water	#2	**Munic.**, MNR, MOEE, Env. Can.
c. alternative P-free products	#1	**Landowner**, MOEE, Env. Can. (Info)
d. phase out products with contaminants	#1	**MOEE**, Env. Can.
e. control bacteria	#2	see Actions 3. and 4.
f. monitor for sources	#1	**MOEE**
9. INPUT & REVIEW		
a. model OPA	#2	**Munic.**, MMA, MOEE
b. Storm Management Plans	#2	**Munic.**, MNR, MOEE
c. farm plans	#3	**Landowner**, NSSCIA, OMAF
d. FHMP review	#1	**MNR**, Munic.

Note: Priority #1 = those actions for which implementation is clear and can proceed.
Priority #2 = those actions that will be preceded by short-term study of technology and/or cost.
Priority #3 = those actions identified as requiring longer-term study to understand cause and effect of remediation and additional consultation prior to implementation.

Review of the Effectiveness of Remedial Actions (Section 4 cont'd)

Actions controlling phosphorus were reviewed to determine the potential phosphorus that could be removed from the supply now entering Severn Sound using available technology. The greatest potential reduction of phosphorus supply can be achieved through upgrades to the sewage plants serving Severn Sound communities (over 8,000 kg/yr). The next most important reduction should come from private shoreline systems (4,800 kg/yr) followed by the watershed sources (3,000 kg/yr). Eliminating existing urban stormwater sources such as combined sewer overflows and sewage bypassing will provide another significant reduction in supply (1,200 kg/yr). (see Table C)

The effect of the phosphorus control strategies was evaluated for four areas in Severn Sound to determine whether the RAP objectives could be met. The greatest improvement is expected in Penetanguishene Bay where open water total phosphorus concentration should be less than 20 ug/L from the existing 37 ug/L. This should result in substantial relief from nuisance algae growths and improved water clarity in spite of forecasted growth in population. The open part of Severn Sound should also improve (from an average total phosphorus concentration of 17 ug/L to less than 15 ug/L). The other two areas evaluated (Sturgeon Bay and the Port Severn area) are expected to change the least. Dramatic improvements in stream water quality are also expected in the Wye River and Coldwater River following phosphorus control at sewage plants. The greatest reduction in watershed sources should occur in the Wye, Hog and North River watersheds and result in improvements especially in the Wye and Hog where the most extensive areas of farming are located.

The actions that will lead to a healthy fish and wildlife community in Severn Sound involve the protection and rehabilitation of habitat and restoration of predators such as walleye.

The rehabilitation of tributary habitat, through restricting livestock access, stabilizing stream banks and planting trees and shrubs in retired valley lands is proceeding through the Severn Sound Tributary Rehabilitation Program. Fencing and rehabilitation is required on 38 km of stream in the immediate watershed of Severn Sound. This will have the combined effect of improving stream quality and improving the stream habitat.

The coastal habitat and its relation to the fish community requires further assessment. However, there are 129 km (37% of the surveyed shoreline) of shoreline that provide unique and essential habitat, such as spawning areas, nursery areas and wetlands. In order to protect these areas an interim fish habitat management plan is proposed that would restrict the shoreline construction activities permitted. Some shorelines offer limited habitat due to destruction or elimination of littoral areas (shallow, productive habitats) during shoreline development (12 km or 4% of surveyed shoreline). The rehabilitation of habitat as special projects or as part of shoreline development proposals will be actively encouraged in these areas. These measures will improve the productive capacity of Severn Sound and, along with other good fisheries management, lead to a self-sustaining, balanced fish community in Severn Sound.

Socio-Economic Considerations (Section 5)

Preliminary cost estimates for the phosphorus control actions are summarized in Table C. The potential total capital cost for implementing the RAP is $62 million including $22 million for sewage plant upgrades; $35 million for storm water management; $4.1 million for agricultural source controls and $1 million for eliminating combined sewer overflows and raw sewage bypass at pumping stations. Revised estimates of storm water costs are underway along with discussion of best management practices necessary to meet RAP objectives.

The cost of rehabilitating tributary habitat overlaps with the watershed phosphorus control costs. Coastal habitat protection and rehabilitation is largely a matter of ensuring no net loss of habitat through planning and development controls. However, specific projects such as the Matchedash Bay Project will protect and restore habitat through direct expenditures on land and habitat restoration. The Matchedash Bay Project is a separate effort of the North American Waterfowl Management Plan (NAWMP) agreement between Canada and the United States. Direct funding through the RAP program is not necessary. Minor funding for monitoring and evaluation as part of the RAP surveillance plan may be the only RAP funds expended directly on habitat restoration.

The relatively small municipalities operating communal sewage systems in Severn Sound area have been eligible, under the existing provincial grant structure, for assistance in sewage upgrade projects such as those required by the RAP. Financing the upgrading of sewage plants in many municipalities including those in the Severn Sound Area of Concern has become a great burden on finances, taxation and on taxpayers. Full-cost pricing represents perhaps the most efficient and equitable mechanism for paying the municipal share of the water-related infrastructure upgrades required for RAP implementation.

Funding of three sewage plant projects ($12.5 M), two pumping stations ($1 M) and assistance for agricultural source control ($4.4) has been confirmed to date. Other remedial actions such as storm water planning, marine construction proposals, fish habitat management plans and Official Plan Amendments require support of existing planning, approval and review agency staff and municipal planning staff in considering the RAP as development proposals are made.

Walleye stocking is carried out by volunteer anglers groups in the area under MNR Community Fisheries Involvement Program (CFIP).

TABLE C:

COST SUMMARY OF REMEDIAL ACTIONS TO CONTROL PHOSPHORUS IN SEVERN SOUND

SOURCE	TOTAL PHOSPHORUS LOAD (kg/y)	POTENTIAL PHOSPHORUS REDUCTION (kg/y)	ANNUAL COST ($K/y)	COST EFFECTIVENESS ($/kg.y)
SEWAGE PLANTS	10,888	8,122	2,748	338
PRIVATE SYSTEMS(1)	6,000	4,800	300	202
URBAN STORM WATER exist CSO/Bypass storm (2)	 1,216 3,133	 1,216 627	 100 3,500	 82 5,600
WATERSHEDS(3)	14,761	2,952(4)	527	10-1,000(5)

Notes (1) Assuming 20% of 3,000 systems need replacement @$5K each.
(2) Assuming 20% potential reduction in phosphorus load, costs using unit storm costs and areas from Hickling (1992).
(3) Excludes Severn River at 24,400 kg/y.
(4) Assuming 20% potential reduction in phosphorus load. Costs estimated as in Section 5.4.
(5) Costs calculated for four actions ranging in cost effectiveness.

The benefits of the RAP to the Severn Sound area include: employment and income generated from capital projects, increased recreational opportunities, potential increased property values, social benefits and reduced cost of infrastructure. The benefit of RAP implementation will be greatest for tourism and recreation opportunities and the indirect benefit to the local municipalities of freeing up development potential due to lack of sewage treatment capacity. With sustainable development, the quality of the Severn Sound environment is assured.

Implementation (Section 6)

A structure for implementation is proposed that will consist of the following:

- An **Implementation Public Advisory Committee** (SSIPAC) composed of representatives of ratepayers associations, conservation groups, representatives of the farming community and other stakeholder groups.

- An **Implementation Steering Committee** (SSISC) composed of government, municipal and the Implementation Public Advisory Committee chair.

- An **Implementation Office** with responsibility for coordination of RAP activities in the area. The office would consist of the Severn Sound RAP Implementation Coordinator and implementation support staff with representation from the participating agencies as required.

- **Implementation Work Groups** (8) charged with following up specific areas of remedial action with membership from agencies and the IPAC.

A proposed "fast track" scenario of RAP implementation based on estimated time required for approvals, design and construction, suggests that five years would be required for implementation to take place. This estimate does not take into account funding arrangements or the effect of technology innovation or changes in treatment requirements expected (especially for eg. storm water treatment). The specific actions, responsibilities, schedule and funding for each remedial action will be confirmed during the implementation phase. Agreements and/or positions of government agencies, municipalities and other key stakeholder groups will be developed and reported annually along with progress on meeting delisting objectives, surveillance and monitoring reports and assessments of remedial actions.

Public Involvement (Section 7)

Public consultation for the RAP began in the fall of 1988. In February 1989, a group of concerned citizens representing local governments and interest groups formed the Severn Sound RAP Public Advisory Committee (PAC). The PAC facilitates the exchange of ideas between the RAP Team and the general public. With the help of the RAP Team, the PAC developed a public consensus on the water use goals for Severn Sound. The use goals led to an initial discussion of remedial actions that could be taken to improve the quality of Severn Sound and restore impaired uses. The PAC communication of remedial options to the public during the summer of 1990 resulted in a consensus on the preferred remedial options in the spring of 1991 (Severn Sound PAC, 1991).

Surveillance and Monitoring Plan (Section 8)

The monitoring plan for Severn Sound requires several activities to track the open water response to remediation, the fish and wildlife response, the effectiveness of the remedial actions and the status of contaminant trends and sources. It is also important to track the shoreline activities (eg. construction of marinas and docks) in order to ensure that planning processes take into account the concerns for destruction of habitat.

1. INTRODUCTION

Severn Sound is a group of Bays in southeast Georgian Bay (Figure 1.1). The Sound has been listed by the U.S./Canada International Joint Commission (IJC) as an "Area of Concern" with respect to deteriorated environmental quality (WQB, 1985). In accordance with the International Great Lakes Water Quality Agreement between Canada and the United States (GLWQA, as amended by the 1987 Protocol), a Remedial Action Plan must be developed.

The Severn Sound Remedial Action Plan is being developed by the federal and provincial governments under the Canada-Ontario Agreement Respecting Great Lakes Water Quality. Since 1987 the Severn Sound RAP Team, composed of federal and provincial agency representatives has been working with the public to develop the RAP. The development of the Severn Sound Remedial Action Plan (RAP) has reached the transition between study and action. Two main problems affect the Sound, namely:

1. Eutrophication as exhibited by excessive algae growth and oxygen depletion of bottom waters.
2. Undesirable changes in fish populations.

It is clear that environmental conditions in Severn Sound must improve. The existing quality attracts heavy recreational use. The goals of this plan, as developed through an extensive public consultation process, are as follows.

GENERAL GOALS

1) to improve water quality in Severn Sound
2) to maintain a healthy ecosystem in Severn Sound

WATER USE GOALS:

1) the water should be swimmable virtually everywhere in Severn Sound
2) the fish and water-based wildlife habitats in Severn Sound should be protected to maintain their healthy, naturally reproducing communities
3) the fish from Severn Sound should be edible

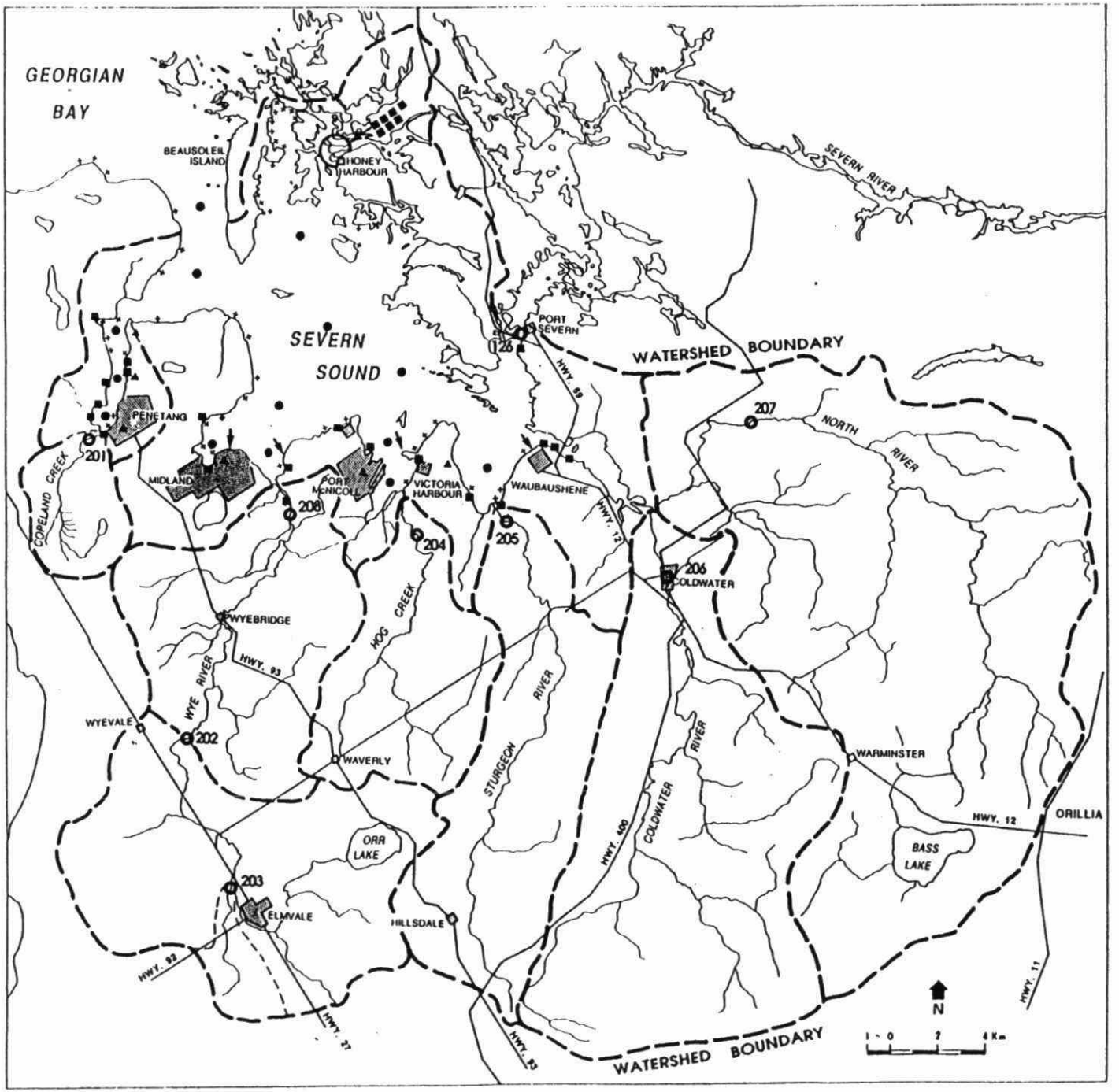


FIGURE 1.1 Severn Sound and watershed

LEGEND:

- Tributary monitoring stations
- Open water sampling locations
- Swimming areas
- Sewage plant discharges
- Marinas
- Surface water intakes
- Boundary of area of concern

The purposes of this document are:

- To provide an update of the environmental status of Severn Sound
- To outline the area-specific objectives for restoration of impaired water uses
- To review the recommended remedial actions showing how the actions will lead to restoration of environmental quality
- To explore the preliminary costs and benefits of remedial action
- To propose a structure and schedule for implementation
- To show how the public has been involved in the process
- To explain how the effects of the plan will be monitored

Severn Sound will be the final repository of any failure to achieve lasting restoration of environmental quality. Unless all those living in and contributing to Severn Sound adopt a caring, think-ahead attitude to their actions in the future, Severn Sound will continue to be an area of concern. The responsibility for clean up and protection of environmental quality is shared by everyone.

The Remedial Action Plan Process

According to the GLWQA a remedial action plan must be submitted to the IJC at 3 stages:

1. ***when the definition of environmental conditions and problems is complete;***

2. ***when remedial and regulatory measures have been selected; and***

3. ***when beneficial uses have been restored.***

In September, 1988 the RAP Team produced a document entitled "Severn Sound RAP: Environmental Conditions and Problem Definition Part 1". The document was submitted to the International Joint Commission and was accepted as achieving Stage 1 in June 1991 (Severn Sound RAP, 1988).

Public consultation is a very important, ongoing component of the RAP. A Public Advisory Committee (PAC) of stakeholders began meeting in February 1989 to ensure their ideas were being considered by the RAP Team. The PAC now includes almost 40 stakeholders including individuals, representatives of local governments and interest groups. Together with the RAP Team they developed water use goals for the Severn Sound. Discussion of remedial actions to restore these goals followed. At the same time, many events and meetings were arranged to involve as many people of the Severn Sound community as possible in the RAP process. A consensus was reached on the preferred remedial options in the spring of 1991 (Severn Sound PAC, 1991).

The evaluation of remedial options has continued between the RAP Team and the PAC. In addition, the status of use impairments has changed since the Stage 1 submission. Table 1.1 provides a summary of the current status of use impairments described in Annex 2 of the GLWQA as applied to Severn Sound.

The next step in the process will be to implement the recommended actions described in this document. This will require a consultation with key stakeholders to confirm detailed positions on how and when each action will be implemented and the responsibilities.

TABLE 1.1
STATUS OF USE IMPAIRMENT IN SEVERN SOUND

POTENTIAL IMPAIRED USE	SIGNIFICANCE TO SEVERN SOUND RAP AT STAGE 1 SUBMISSION (1988)	STATUS FOR STAGE 2
i) Restrictions on fish and wildlife consumption.	Human consumption advisory on: walleye greater than 45 cm; smallmouth bass greater than 35 cm; rainbow trout greater than 65 cm; white sucker greater than 35 cm; not attributed to local sources of mercury of PCBs. No other restrictions	Restrictions based on Mercury only: Walleye greater than 55 cm; smallmouth bass greater than 35 cm; northern pike greater than 75 cm. No restrictions on rainbow trout or white sucker
ii) Tainting of fish and wildlife flavour.	No reports of any tainting	No change
iii) Degradation of fish and wildlife populations.	Walleye declined in late 1970's. Black crappie increased to peak in early 1980's. Causal factors under investigation.	Walleye numbers still low. Causes still under investigation.
iv) Fish tumours or other deformities.	Tumours or other deformities not reported.	No change
v) Bird and animal deformities or reproduction problems.	Wetlands continue to support healthy communities.	No change
vi) Degradation of benthos.	Benthic community typical of eutrophic conditions; resident fauna do not have elevated tissue concentrations of contaminants.	No change (1988, 1990 survey of benthos and sediment toxicity)
vii) Restrictions on dredging activities.	Concentrations of metals and PCBs in localized sediments in excess of the open water disposal guidelines.	Bulk chemistry still exceeds OWDGs. However, 1990 sediment bioassessment study concluded sediments with highest bulk chemistry concentrations non-toxic.
viii) Eutrophication or undesirable algae.	Phosphorus exceeds 20 ug/L in the Sound and algae blooms have been reported. Algal growth may impair swimming, boating and aesthetics.	No change.
ix) Restrictions on drinking water consumption, or taste and odour problems.	No reports of any taste and odour problems. No restrictions for use as a raw water supply with treatment prior to drinking.	No change.

TABLE 1.1
STATUS OF USE IMPAIRMENT IN SEVERN SOUND

POTENTIAL IMPAIRED USE	SIGNIFICANCE TO SEVERN SOUND RAP AT STAGE 1 SUBMISSION (1988)	STATUS FOR STAGE 2
x) Beach closings.	No reported beach closings.	Sheltered bays in Beausoleil Island closed to swimming during summer 1989 to present. Related to presence of boats.
xi) Degradation of aesthetics.	Current level to be maintained or improved.	Aesthetics expected to improve (fewer scums of algae and improved clarity).
xii) Added costs to agriculture or industry.	No reported costs due to water quality impairment.	Costs may result from zebra mussel introduction to the area.
xiii) Degradation of phytoplankton and zooplankton populations.	Typical community associated with eutrophic waters. No evidence of any toxic effects in growth studies.	No change.
xiv) Loss of fish and wildlife habitat.	Potential for loss due to shoreline alteration and marina construction.	Continues to be of concern; habitat surveys ongoing.

2. ENVIRONMENTAL STATUS OF SEVERN SOUND

The International Joint Commission (IJC) review of stage 1 stated that the RAP and supplemental information provided for the review adequately "defines the environmental problems, identifies impaired uses and describes the degree of impairment and its geographic extent".

Two problems were originally identified in Severn Sound:

1. *Eutrophication or nutrient enrichment, and*
2. *loss of habitat and degraded fish populations.*

Comparatively little contamination from trace contaminants (organic and inorganic) and bacteria has been found. Emphasis was placed on prevention of contamination. Surveillance and monitoring of contaminants in sediment, sewage sludge and effluent and fish and wildlife tissues were conducted to establish trend baselines and to screen for sources.

The review also pointed out some remaining gaps in information on environmental conditions and cause-effect relationships and recommended assessment and research in the Sound. Gaps identified by the RAP team, at the time of Stage 1 submission, and the IJC review are listed with current status in Table 2.1.

The gaps identified have been pursued by the RAP Team over the years since submission of the Stage I document (1988-1992). Apart from ongoing work on the two identified problems, eutrophication and loss of habitat and degraded fish populations, work on filling these gaps has been completed and will be reported in technical studies.
The following sections summarize the status of environmental conditions in Severn Sound.

TABLE 2.1
CURRENT STATUS OF GAPS IDENTIFIED BY THE RAP TEAM, AT THE TIME OF STAGE 1 SUBMISSION, AND BY THE IJC REVIEW.

GAPS IDENTIFIED IN STAGE 1	STATUS
Restrictions on Fish and Wildlife Consumption	
1. Investigation of potential local sediment sources or active discharges of PCBs and mercury.	1. None noted (see section 2.3)
2. Sediment bioassessment of areas with elevated bulk sediment chemicals.	2. Sediment not acutely toxic or sublethal to test organisms, some bioavailable chromium in Penetang Bay
3. Establish trends in tissue contaminant levels in key biomonitors representing localized young fish, sport fish, fish eating birds and birds and animals with water-based localized range.	3. No significant uptake of lead or other metals in collections of Carp ('82, '88), Walleye ('76, '77, '89), baseline spottails ('87), Osprey, Herring Gull, Caspian Tern, Common Tern, Red Wing Blackbird eggs and Tree Swallow eggs ('90, '91).
Degradation of Fish and Wildlife Populations/Loss of Fish and Wildlife Habitat	
4. Inventory nearshore habitat of the Severn Sound	4. 70% North shore 50% South surveyed. Reporting and surveys of new sections in progress.
5. Investigate cause - effect linkages between changes in fish community and factors such as loss of habitat, changing water quality and increased recreational fishing pressure.	5. Ongoing, expect results by 1995. Creel survey of 1992 completed. Index netting at historical site continues to track improvements in walleye abundance and fish community in general.
Bird or Animal Deformities or Reproduction Problems	
6. Data from the Severn Sound area on fish eating birds should be collected for comparison with other Areas of Concern.	6. Nesting surveys of colonies in the Severn Sound area ('89,'90, '91) indicate low incidence of defects as compared to other Great Lakes sites.
Eutrophication or Undesirable Algae/ Degradation of aesthetics	
7. Additional assessment of the relative contribution of phosphorus sources of Severn Sound is required including point, rural, urban, shoreline and sediment sources.	7. Source monitoring ongoing - STP review completed (XCG, 1991) - 3 yrs tributary export measured - 90% shoreline system surveyed - Availability of phosphorus in Penetang Bay sediment under further investigation. Other areas not considered significant source.
8. The phosphorus budget estimated for Penetanguishene Bay (Stage 1) should also be estimated for the open Sound, Sturgeon Bay and the Port Severn area.	8. Calculated budgets, see section 4.3
9. The effect of implementing remedial actions of reduce phosphorus supply on the immediate receiving water and the budget areas should be assessed.	9. Evaluated especially for controllable sources, see section 4.
10. Continue monitoring of sources and open water.	10. Ongoing
Degradation of Phytoplankton and Zooplankton Populations	
11. Information on zooplankton community structure and changes should be provided.	11. Assessment completed for available data ('78 - '89). Assessment for '90 to '92 ongoing. Bythotrephes cederstroemi is a potential problem to the zooplankton community and ultimately to the food chain (e.g., larval fish food).

2.1 Eutrophication Status

Excessive algal growth in Severn Sound, particularly in Penetang Bay, has been of public concern since the mid 1960's. The algae growth forms unsightly scums and layers of turbid water that discourage recreational uses such as swimming. The algae growth may also relate to recent changes in the fish caught from the Sound to species more tolerant of nutrient enrichment. Historically, the collapse of the resident coldwater fishery may also have been related to changes in water quality conditions. Boating and swimming are adversely influenced in some areas of Severn Sound where heavy growths of rooted aquatic plants occur (e.g. Sturgeon Bay).

Nutrient Enrichment Status

Phosphorus is a key nutrient that limits the growth of algae in Severn Sound (Nicholls and Heintsch, 1992).

A significant relationship between increasing total phosphorus concentration and increasing algae density, as indicated by chlorophyll a concentration, was found for Severn Sound (Figure 2.1; Gemza, 1993). The chlorophyll - phosphorus relationship for Severn Sound indicates that a successful reduction in algal biomass in Penetanguishene Bay should become apparent when mean annual total phosphorus concentration falls below 20 ug/L. Moreover, relief from nuisance growths of algae should result from reducing mean total phosphorus concentration to less than 15 ug/L.

The water quality response of Severn Sound to reduced phosphorus loadings from municipal sewage plant discharges has been positive in some areas. The phosphorus concentration in Sturgeon Bay decreased significantly in the period since the Victoria Harbour sewage plant started operation (1984 to 1991 compared to 1973-1983 period; Gemza, 1993). In other areas, reductions in sewage plant effluent phosphorus loading have been offset by growth in sewage flows and bypassing. In these areas (Penetang Bay and the open Severn Sound) present phosphorus loading limits have failed to result in the significant decreases in open water phosphorus concentration leading to reduced algal density and improved water clarity.

Total phosphorus concentrations have shown a general, slight decline between 1969 and 1991 at all stations including those in Midland and Penetanguishene Bays, which receive the largest discharges from sewage treatment facilities. However, an increasing trend is apparent in recent years (Figure 2.2) suggesting that long-term decreases may not be sustained under current loadings. Phosphorus levels are still high enough to promote nuisance algal growths, particularly in the southern portion of Penetanguishene Bay. The density of algae in Severn Sound had not shown a significant decline similar to phosphorus concentration over the same period. Chlorophyll a concentrations are generally greater than 10 ug/L in the south end of Penetanguishene Bay. Chlorophyll a concentrations of 5 to 10 ug/L have been found to coincide with nuisance algae conditions that interfere with swimming use. Water clarity (as measured by Secchi disc) has significantly worsened throughout Severn Sound with the

exception of Sturgeon Bay where visibility to the bottom continues in most areas of the Bay.

Seasonal changes in quality show a double-peak pattern in total phosphorus first in May - early June and then in fall. The early spring total phosphorus concentration (following ice breakup) is generally lower than the previous fall and gradually increases in May and early June in response to seasonal increases in phosphorus inputs. This means that input of phosphorus through the ice-free period influences the open water quality.

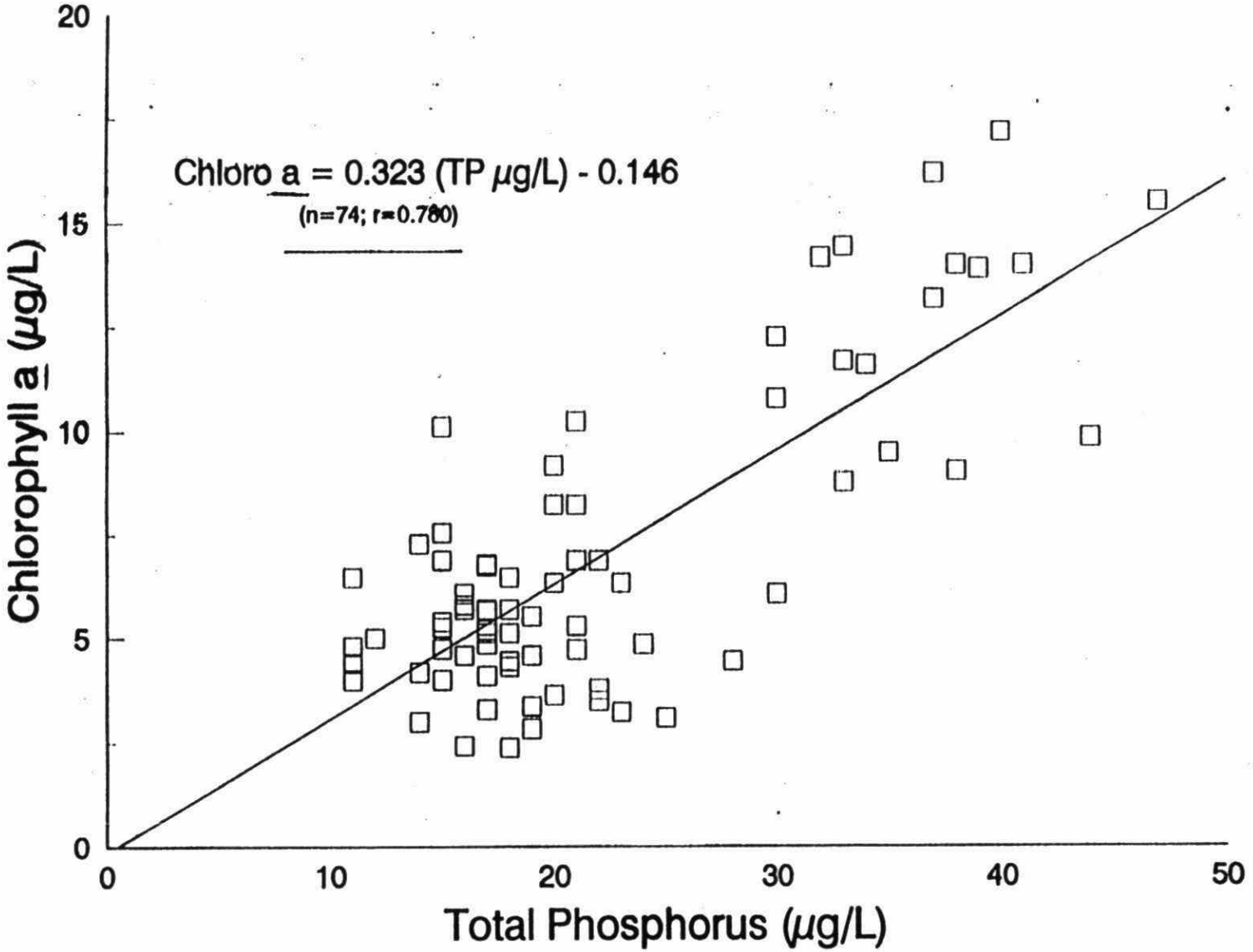


Figure 2.1: Relationship between mean annual chlorophyll a and total phosphorus levels at stations P1, P4, M1, PM2 and BS between 1973 - 1991.

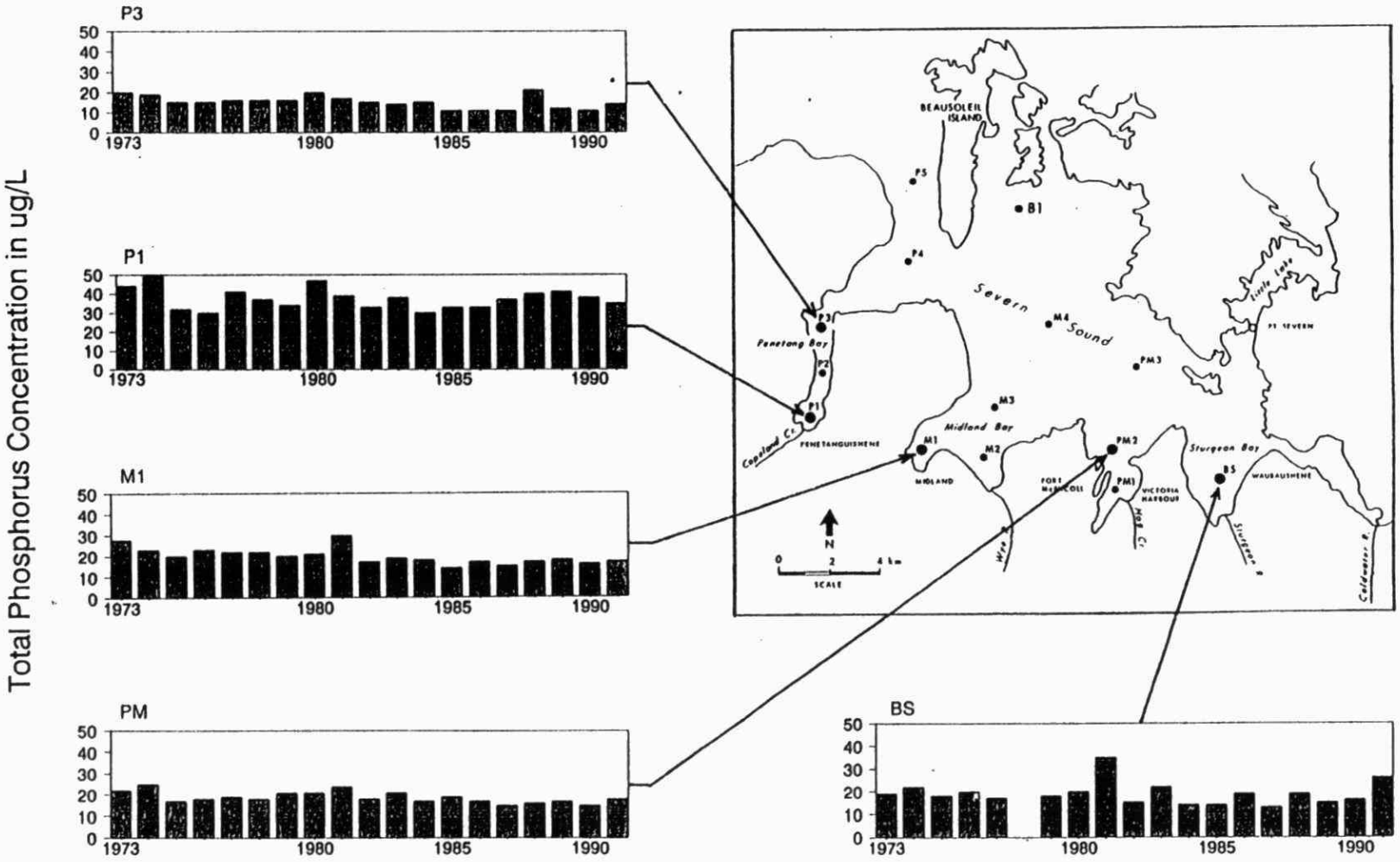


FIGURE 2.2 Mean Total Phosphorus Concentration at selected sites in Severn Sound

Phytoplankton

The phytoplankton composition of Severn Sound was similar to the composition in Lake Huron (Munawar and Munawar, 1986; 1988) although relative abundance was much greater. Seasonal patterns were similar to those observed in eutrophic (nutrient enriched) Saginaw Bay, Lake Huron (Stoermer and Theriot, 1985), as well as some of the nearshore waters of the North Channel, Lake Huron (Munawar et al. 1988). Gradients of degraded water quality were also observed in these systems, similar to the gradient in Penetang Bay: conditions became less eutrophic with distance from point sources and regions of heavy lakeshore development.

The algal community in Severn Sound was dominated by diatoms, blue-green algae and green algae, especially by species indicative of eutrophy such as *Melosira* sp. and *Stephanodiscus* sp. (Hutchinson, 1967). Other species of diatoms such as *Cyclotella* sp., normally associated with nutrient poor or oligotrophic waters, (Hutchinson, 1967; Dixit et al., 1992) were absent from Penetanguishene Bay but were well represented in Sturgeon Bay. Chrysophytes, another class of algae associated with moderately enriched or poorly enriched waters, (Munawar, 1986) were generally absent in Penetanguishene Bay and were poorly represented in the open Sound. Sturgeon Bay has a more even representation of all algae classes (including the Chrysophytes) as would be expected in a mesotrophic or moderately enriched water body. The more stringent effluent phosphorus requirement for the Village of Victoria Harbour sewage plant has resulted in minimal impact of the discharge on the algal community of the Bay.

Diatom abundance in Severn Sound determined the annual algal density cycle. The seasonal diatom cycle of spring and fall maxima with reduced diatom significance during the warm summer months was most likely a result of a combination of nutrient availability and temperature fluctuations. The diatom group in general has been observed to grow preferably during the spring and fall periods in the open waters of the Great Lakes (Munawar et al., 1986) and similarly in many nearshore areas (Stoermer and Theriot, 1985; Nicholls and Heintsch, 1986) although in some well mixed eutrophic areas of the Great Lakes, spring dominance by one diatom species relented to mid-summer dominance by another. This appears to have been the case in parts of the Bay of Quinte (Nicholls et al., 1986) when early season dominance by *Stephanodiscus* sp. was followed by summer peaks of *Melosira* sp.

Response in the phytoplankton (or suspended algae) community provides preliminary indications that the trophic status of the open waters of the sound may be improving. Several species indicative of eutrophy, however, continue to dominate the algal assemblage. Secchi disc transparency, a key trophic state variable, continues to worsen with mean annual and spring water clarity levels declining throughout Severn Sound.

Zooplankton

Crustacean zooplankton or water fleas are small animals living in the water column in lakes. Some zooplankton species eat by filtering algae while others are predators of other small animals. They provide an important food supply to young and some adult fish.

The forty three species found in Severn Sound waters (Appendix 2.2) represents a high diversity for a nearshore Great Lakes embayment. By comparison, Carter and Watson (1977) found 23 species in the North Channel and Georgian Bay. Carter (1972) noted 27 species in other northern Georgian Bay embayments. In the Bay of Quinte, another nutrient enriched embayment in Lake Ontario, two separate studies (Cooley et al.,1986; Evans et al.,1980) found 34 and 51 species respectively. Despite the high number of species found in Severn Sound, consideration of how well represented each species is within the entire community suggests that diversity could be decreasing (Pope, 1990).

The abundance or biomass of zooplankton in Severn Sound is strongly related to the trophic status or level of enrichment in the vicinity sampled (Gemza, 1993). Comparatively high abundance was found in the south end of Penetanguishene Bay at station P1 (Figure 2.3). Abundance and biomass estimates for the open water stations P4, P5 and BI were comparable to published data from the North Channel (Sprules et al., 1988) and Twelve Mile Bay (Carter et al., 1993).

The zooplankton species that "graze" the algae in Severn Sound are very important to maintaining a balanced ecosystem and controlling the algae density. The most important grazers are the larger bodied cladoceran zooplankton, especially *Daphnia* species. These species are also the most favoured food items of zooplankton-eating fish (zooplanktivores) and their abundance has been shown to decrease when zooplanktivores increase in abundance (Evans and Jude, 1986; Kitchell and Carpenter, 1988; Hurley et al.,1986). Large-bodied zooplankton in Severn Sound decreased in abundance during the 1982 - 1988 period, especially at station P1 (Figure 2.3). This period coincides with an increase in abundance of the zooplanktivorous black crappie (Craig, 1993). Further studies of the factors controlling zooplankton abundance and the algae-zooplankton-fish community interactions are needed in Severn Sound to provide the technical basis for management of the Sound to achieve a healthy, balanced community.

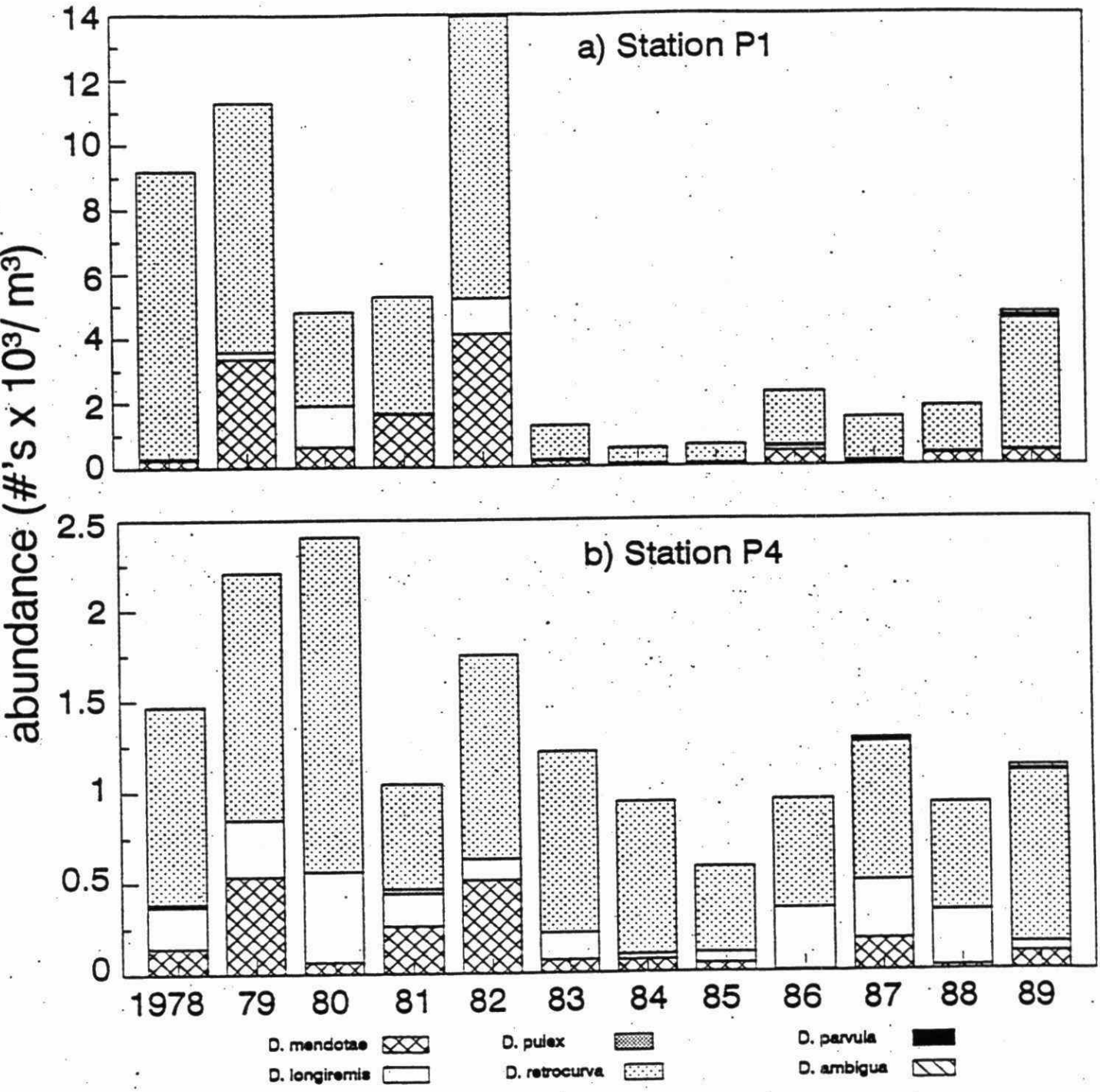


Figure 2.3: Mean annual daphnid abundance at Station P1 and P4 between 1978 and 1989.

Benthos

Benthic macroinvertebrates integrate and reflect the quality of a water body. The presence/absence of species with known requirements, their abundance and the species composition can all provide an indication of nutrient enrichment and/or the presence of toxic factors.

There are many factors that influence the relative abundance of the benthos in shallow bays of the Severn Sound. These can include the presence of rooted aquatic plants, the bottom substrate (rocky, sandy, muddy), exposure to wind and wave action, nutrient enrichment and toxic contaminants.

Studies of Sturgeon Bay benthos (Barton, 1981; 1983) concluded that the community in the mud was typical of a shallow, weedy bay with both species tolerant of nutrient enriched conditions (such as worms and large midge larvae). Tolerant organisms tended to be more abundant toward the west side; more because of shelter from wind and wave action than because of nutrient enrichment. Areas with aquatic plant beds supported a more diverse community. Milfoil was found to support a wide variety of organisms with abundance significantly correlated with size of plants. The purpose of the work during 1980 and 1982 was to document conditions in the bay, prior to operation of the Victoria Harbour WPCP. In 1988, a survey of benthos in Sturgeon Bay was conducted to repeat the earlier work after the start up of the Victoria Harbour WPCP in 1985 (Speller and Pope, 1989).

Without exception, the 1988 diversity of invertebrates on living plants (the epiphytic invertebrates) was lower than that found in 1980 or 1982. This may have resulted from seasonal differences in samples (July 1980, July 1982, Sept. 1988) and from differences in the dominant plant species sampled (*Myriophyllum spicatum* in 1980 and 1982 vs. *Elodea canadensis* in 1988). The 1988 results suggested that diversity was higher at those sites further away from the Victoria Harbour WPCP outfall. Both indices of community or abundance suggested that Sturgeon Bay was typical of mesotrophic conditions as were present prior to the construction of the Victoria Harbour sewage plant.

Barton (1983) and Jaagumagi (1986) studied benthos in Penetang Bay. Barton's results indicated a pattern of decreased abundance and diversity near the old Penetanguishene WPCP (Main St.) increasing with distance out into the south portion of the bay. Highest diversity was found in the mid-bay area off the site of the then-proposed Penetang Fox St. WPCP. This pattern suggested that some toxic factor was influencing the community near the Main St. WPCP outfall. Jaagumagi (1986), in a sample close to the same WPCP outfall, also concluded that some form of toxicity was influencing the community. The 1988 sampling in Penetang Bay (Speller and Pope, 1989) also confirmed increased abundance of sludge worms (a group generally tolerant of pollution).

Jaagumagi (1986) also studied benthos in Midland Bay. He found, in general, that the benthic community was typical of good water quality but that the community at sites in the

inner harbour indicated moderately enriched or mesotrophic water quality.

The benthos of the open areas in Severn Sound, as well as Hog Bay, have been studied by Environment Canada. Results are not available at this time.

Algae Control in Severn Sound

Nuisance algae growths in Severn Sound stem from two main controlling factors: phosphorus concentration and fish community balance. Phosphorus is generally the key nutrient that determines the growth of algae in the Sound. Some sources of phosphorus are uncontrollable, such as the phosphorus supplied from the atmosphere (precipitation and dust) to the water surface. Other sources, such as municipal sewage plant discharges, originate from human activity and can be controlled to varying degrees.

Algae growth is also affected by the fish community through the food chain. A balanced fish community controls the cropping or grazing of algae by influencing the abundance of "algae eaters" or zooplankton in the water body. The "algae eaters", especially the large water fleas *Daphnia* sp., act to control the density of algae through grazing and are a preferred food by fish.

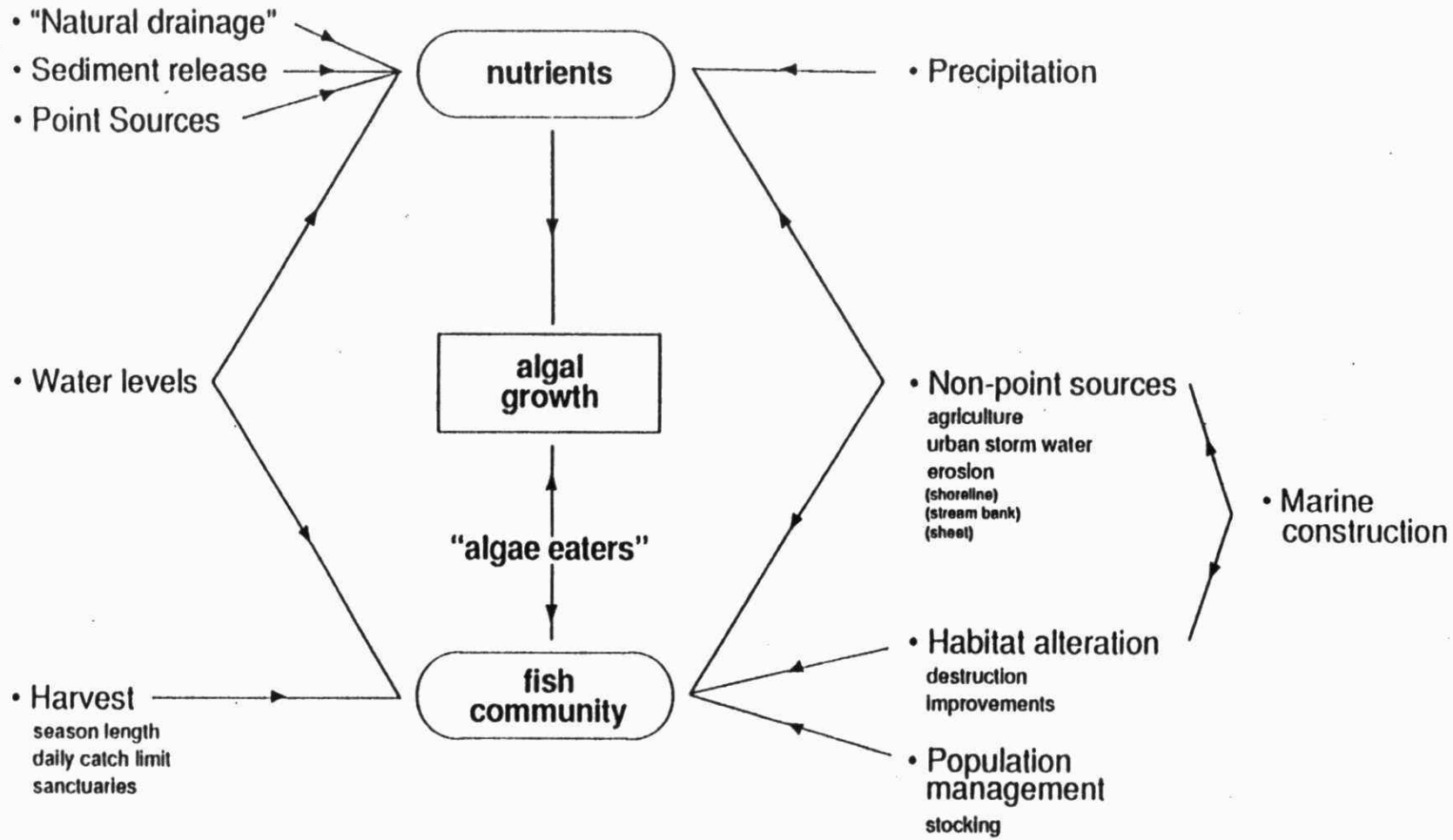
The complex interactions of sources of nutrients and human activities that influence algae growth are outlined in Figure 2.4. For example, the decline of a predator fish population due to destruction of habitat, overfishing or poor reproduction could lead to an over abundance of smaller fish that eat the "algae eaters". The excessive removal of "algae eaters" could then result in increased algae, which may reduce oxygen in the water column and ultimately impact fish populations and other water users.

Experience with water quality complaints and studies of mean algae density in relation to nuisance algae densities (Nicholls, et al. 1978; Dillon et al. 1986) suggest that mean algae densities will be low enough to provide reasonable protection from nuisance algae conditions at total phosphorus concentrations of less than 10 or 20 ug/L. An algae density of 5 ug/L or higher is generally found to interfere with swimmers' expectations for aesthetic quality (based on experience with complaints of swimmers). The relationship between measured total phosphorus concentration and algae density in Severn Sound (Figure 2.1) indicates that a phosphorus concentration of 15 ug/L or less would result in a reasonable reduction in nuisance algae densities in the Sound and provide the basis for reversing the effects of excessive nutrient enrichment. Presently the total phosphorus concentrations within Severn Sound range from 40 ug/L in Penetanguishene Bay to 16 ug/L in the Port Severn area.

Nicholls and Heintsch (1992) have cautioned that the relative importance of land drainage versus sewage plant sources of phosphorus to phytoplankton growth is determined, not by the absolute quantity of nutrient but indirectly by their influence on nutrient concentration in the receiving waters. They also found that the bioavailability of phosphorus from the

Figure 2.4:

Factors influencing algal growth in Severn Sound



Severn Sound

Severn River varied seasonally. For example, bioavailability of phosphorus supplied by the Severn River in August was only 2-3% of that contributed during April (1985 and 1987). These findings suggest that control of sources such as sewage plant discharges and watershed sources may have an even more beneficial effect on reducing nuisance algae growths.

Target concentrations for the Port Severn area are dependent on the Severn River phosphorus concentration remaining low in relation to Severn Sound. This in turn depends on continued emphasis on maintaining the phosphorus loading targets of the Lake Simcoe Environmental Strategy (LSEMS, 1985).

2.2 Changing Fish and Wildlife Habitat and Communities

Fish Community

The fish community of Severn Sound is large and diverse consisting of 65 recorded species, 54 native and 11 introduced species (Table 2.2). The majority inhabit the Sound year round but some occupy the area only when conditions are suitable. They migrate through the Sound to inflowing streams (salmon and trout) or leave the Sound to offshore waters of Georgian Bay (walleye) as habitat needs dictate for each species.

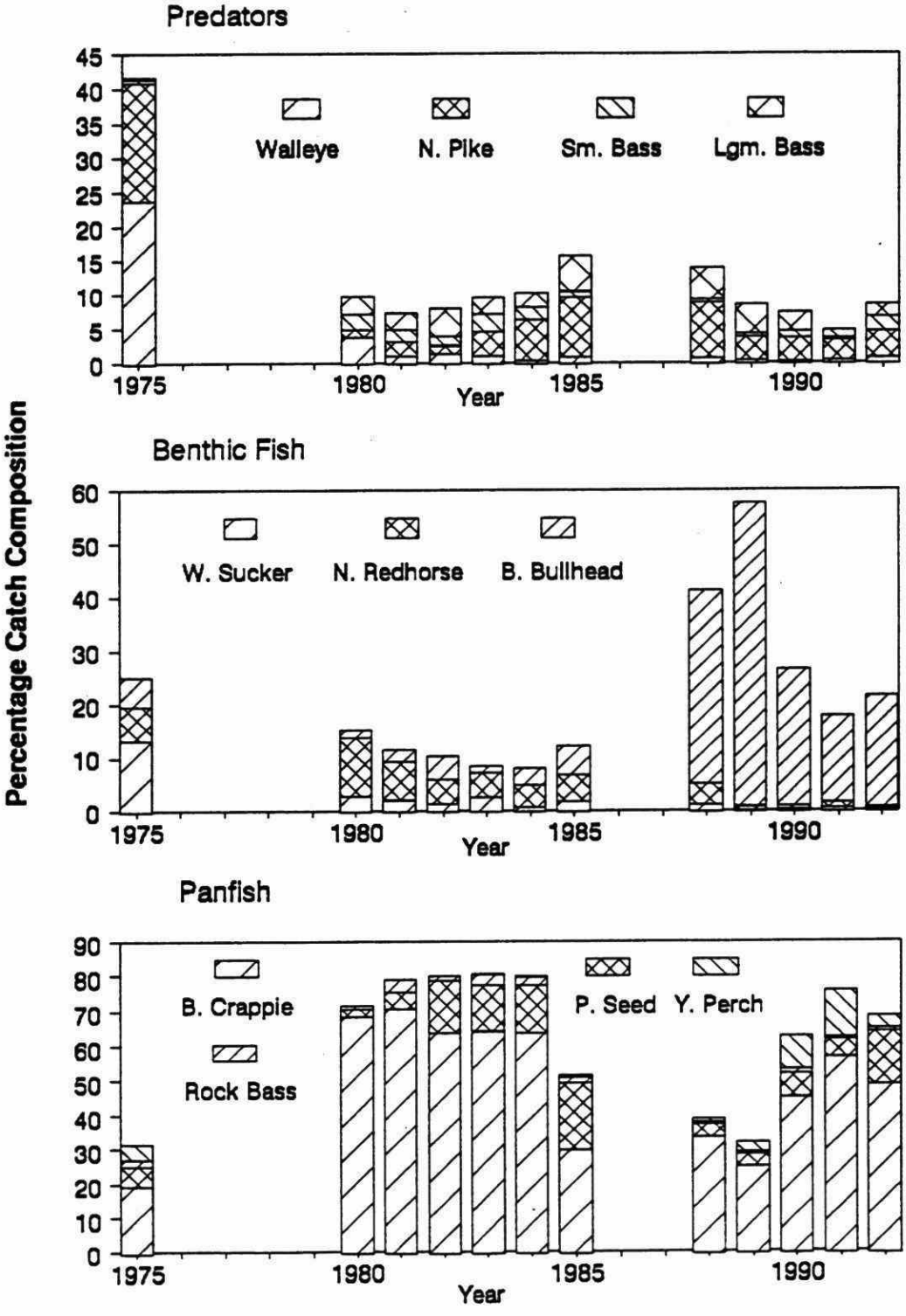
The fish community, as indicated by spring index trapnet catch, is summarized by ecological roles as suggested by Reckahn and Thurston (1991) (Figure 2.5). Panfish are black crappie, rock bass, yellow perch and pumpkinseed sunfish. Predators include northern pike/muskellunge, walleye, smallmouth and largemouth bass. The benthic fish are white sucker, redhorse sucker and brown bullhead.

In 1975 the largest percentage of the catch was predator species (>40%) consisting mainly of walleye and northern pike/muskellunge. Panfish were about 30% of the catch, mainly black crappies (20%). Sucker species dominated the benthic community (25%) with brown bullheads making up less than 5%. By 1980 predators had dropped to less than 10% of the catch with the biggest declines in walleye and the esocid complex while basses had increased from about 1% to 5% or one half of the predator catch. Panfish populations responded and had increased proportionally to 70%, with black crappies equalling almost 66% of the total fish caught. The benthic group dropped to 15% and bullheads remained less than 5% of the total. This community structure changed slightly through 1984 and then in 1985 predator numbers increased to 20% with northern pike comprising one half the predators or 10% of the total catch. Northern pike increases may have been a response to improved spawning success because of rising lake levels which peaked in 1986 (Reckahn and Thurston, 1991). At the same time, black crappie numbers dropped to 40% but still remained the most frequently caught panfish. In 1988, predators dropped to below 10% again while panfish numbers dropped to 40% and benthic species rose above 40%, for the first time, with brown bullheads increasing from about 5% to 40% of the catch. Bullhead numbers rose to over 50% of the total catch in 1989. By 1992, predator numbers remained low, panfish had increased to the highest value since 1988 and benthic have dropped to 25% but bullheads remained high.

During 1990, electrofishing surveys were conducted in inshore littoral habitats of Penetang, Hog and Matchedash Bays (Randall, unpublished data). The electrofishing surveys provided information on the species composition and abundance of fish inhabiting the littoral areas.

Figure 2.5

Composition of catch in Sturgeon Bay as indicated by Spring trapnet samples, 1975-1992



Source: MNR Midhurst District data.

Table 2.2
FISH SPECIES OF SEVERN SOUND
(* indicates non-native species)

sea lamprey*	*Petromyzon marinus*
silver lamprey	*Ichthyomyzon unicuspis*
lake sturgeon	*Acipenser fulvecens*
bowfin	*Amia calva*
tadpole madtom	*Noturus gyrinus*
brown bullhead	*Ictalurus nebulosus*
channel catfish	*I. punctatus*
American eel*	*Anguilla rostrata*
trout-perch	*Percopsis omiscomaycus*
rainbow smelt*	*Osmerus mordax*
lake trout backcross*	*Salvelinus namaycush X S. fontinalis*
brook trout	*S. fontinalis*
brown trout*	*Salmo trutta*
rainbow trout*	*Oncorhynchus mykiss*
pink salmon*	*O. gorbuscha*
chinook salmon*	*O. tshawytsha*
lake whitefish	*Coregonus clupeaformis*
lake herring	*C. artedii*
longnose gar	*Lepisosteus osseus*
banded killifish	*Fundulus diaphanus*
northern pike	*Esox lucius*
muskellunge	*E. masquinongy*
central mudminnow	*Umbra limi*
northern hog sucker	*Hypentelium nigricans*
white sucker	*Catostomus commersoni*
longnose sucker	*C. catostomus*
redhorse	*Moxostoma sp.*
quillback	*Carpiodes cyprinus*

Table 2.2
FISH SPECIES OF SEVERN SOUND
(* indicates non-native species)

carp*	*Cyprinus carpio*
goldenshiner	*Notemigonus chrysoleucas*
emerald shiner	*Notropis atherinoides*
common shiner	*N. cornutus*
spottail shiner	*N. hudsonius*
spotfin shiner	*N. spilopterus*
sand shiner	*N. stramineus*
blackchin shiner	*N. heterodon*
blacknose shiner	*N. heterolepsis*
mimic shiner	*N. volucellus*
northern redbelly dace	*Chrosomus eos*
creek chub	*Semotilus atromaculatus*
brassy minnow	*Hybognathus hankinsoni*
bluntnose minnow	*Pimephales notatus*
fathead minnow	*P. promelas*
alewife*	*Alosa pseudoharengus*
gizzard shad	*Dorosoma cepedianum*
mottled sculpin	*Cottus bairdi*
slimy sculpin	*Cottus cognatus*
burbot	*Lota lota*
yellow perch	*Perca flavescens*
walleye	*Stezostedion vitreum*
logperch	*Percina caprodes*
Iowa darter	*Etheostoma exile*
johnny darter	*E. nigrum*
whitebass	*Morone chrysops*
white perch*	*M. americana*
largemouth bass	*Micropterus salmoides*
smallmouth bass	*M. dolomieui*
black crappie	*Pomoxis nigromaculatus*
pumpkinseed	*Lepomis gibbosus*
bluegill	*L. macrochirus*
longear sunfish	*L. megalotis*
rock bass	*Ambloplites rupestris*
threespine stickleback	*Gasterosteus aculeatus*
brook stickleback	*Culaea inconstans*
brook silversides	*Labidesthes sicculus*

Twenty-seven species of fish were captured in the nearshore areas. Yellow perch (*Perca flavescens*) and pumpkinseeds (*Lepomis gibbosus*) were the most abundant species in all three bays, comprising from 60 to 80% of the total catch (numbers). Other species which Table 2.2 Fish Species of Severn Sound were captured relatively frequently included the black crappie (*Pomoxis nigromaculatus*), white suckers (*Catostomus commersoni*), rock bass (*Ambloplites rupestris*), alewives (*Alosa pseudoharengus*), smallmouth bass (*Micropterus dolomieui*) and largemouth bass (*M. salmoides*). In terms of biomass, predators comprised between 18% (Penetang) and 24% (Matchedash) of the total biomass (Table 2.3). Native species of fish made up from 85% to 90% of the total fish biomass. Generally, these data indicated that the fish communities inhabiting the inshore areas of all three bays were diverse, and all trophic groups were represented, panfish were high and predators low.

Eutrophication and habitat degradation can affect the species of fish present in littoral habitats. Fish biomass can be high in eutrophic areas, but often the biomass is dominated by carp (Lee et al. 1991), which is considered to be an undesirable, non-native species because of its negative affect on the habitat (increased turbidity). Randall et al. (1992) compared fish data in littoral habitats of Severn Sound with data from Hamilton Harbour and the Bay of Quinte. Generally, the biomass of fish was higher in Hamilton Harbour than in any other areas, because of the more eutrophic conditions (phosphorus levels). Although total biomass was high, habitat degradation had a negative impact on the trophic structure of the fish communities. The biomass of carp and other non-native species was higher in Hamilton Harbour, while species richness was lower than in the Severn Sound bays (Table 2.3).

Predators comprised a higher proportion of the biomass in the Severn Sound habitats than in Hamilton Harbour. Using the nearshore fish data, Minns et al. (1992) calculated an 'Index of Biotic Integrity' (IBI), a composite indicator of the health of the littoral fish communities. IBI values for the Severn Sound bays were significantly higher than IBI values for Hamilton Harbour. However, some differences were found among the bays within Severn Sound. IBI values for Penetang Bay were less than values for Hog and Matchedash Bays, largely because predators were less abundant. Minns et al. (1992) warned that Penetang Bay may be perilously close to the transition from a clear to a turbid state. Thus, although data from the inshore areas of Severn Sound generally indicated fish communities that were healthy relative to Hamilton Harbour, habitat conditions in localized areas showed signs of degradation.

Table 2.3: Summary of fish data from Penetang, Hog and Matchedash Bays, as determined by electrofishing in littoral areas (1.5 m depth contour) along 100 m transects in 1990. Data from two areas in Lake Ontario (Hamilton Harbour and Bay of Quinte) are given for comparison.

	Penetang	Hog	Matchedash	Hamilton	Quinte
Number of transects	84	28	36	60	59
Biomass (kg/tran.)	4.8	3.8	3.6	9.1	6.9
Biomass (kg/ha)[1]	160	127	120	303	230
CV of biomass[2]	96	86	71	140	87
% predators	18	23	24	9	25
% native species	91	88	90	38	77
Species richness	5.1	4.8	6.9	4.1	6.7
Mean IBI[3]	57.0	61.2	64.6	28.7	57.4

[1] kg/ha was estimated assuming a catch efficiency of 0.3 and a survey area of 100 m X 10 m.

[2] CV is the coefficient of variation.

[3] IBI is the Index of Biotic Integrity (see Minns et al. 1992).

Walleye Life Cycle in Severn Sound and Population Status

The dramatic decrease in walleye caught by anglers in Severn Sound since the mid 1970's from almost 1500 per year to less than 100 in 1988 continues to be a problem. Anglers caught only 45 walleye during the summer of 1992 (Table 2.4).

The walleye population of Severn Sound has declined significantly. Three factors may have adversely influenced the stock.

- Excessive mortality because of fishing during the 1970's initially reduced the walleye population
- Populations of black crappie exploded, potentially interacting with the declining walleye
- In the 1980's the climate and especially the local weather changed, causing walleye to spawn earlier and fry to emerge possibly before zooplankton biomass is adequate; therefore, survival is lower, year classes are weaker and population recovery is slow.

The life cycle of walleye in Severn Sound has been reviewed extensively in order to determine how the population is adversely affected. The stages are summarized as follows.

1. Spawning: The adult fish usually stage in the Port Severn-Sturgeon Bay area during the winter months. Shortly after ice-out, as water temperatures warm, the fish ascend to their preferred sites and begin the spawning ritual. In the 1970's the spawning run often occurred in late April - early May and lasted for two weeks (OMNR, files). In the late 1980's ice breakup occurred earlier and spawning was completed by mid April. Severn Sound walleye spawn at two known locations associated with tributaries to the main sound. The major site is located in the village of Port Severn in the overflow channel, at Lock 45 on the Trent Severn Waterway. The second spawning location is at Laughlin Falls on the North River.

2. Hatching: Walleye eggs are viable and hatch within 17 - 30 days with about a 90% success rate (based on hatchery conditions using local water). The cultured eggs usually hatch during the first two weeks of May.

3. Larvae to Fingerlings: The walleye larvae grow to fingerlings (5-7 cm) feeding on available zooplankton for about 2 months - May and June - before changing to a diet of forage fish. In the culture ponds, their diet consists almost entirely of *Daphnia* sp. and other large-bodied zooplankton as it apparently does in the wild (Houde, 1964). Repeated efforts to catch larval walleye to confirm their location and potential eating habits in Severn Sound (and in other areas of the Great Lakes) have been unsuccessful. The low large-bodied zooplankton biomass in Severn Sound (Gemza, 1993) in recent years (especially in the early spring) may adversely influence this critical stage now that spawning occurs earlier or they may be susceptible to predation by the large black crappie or brown bullhead populations.

Table 2.4: Summary of Summer Creel Surveys on Severn Sound 1975-1992.

SPECIES	NUMBERS OF FISH CAUGHT						
	1975	1976	1977	1979	1987	1988	1992
longnose gar	-	-	17	3	-	-	9
bowfin	149	149	228	52	161	148	95
chinook salmon	-	-	-	-	19	-	7
rainbow trout	-	-	10	-	-	-	-
backcross lake trout	-	-	-	-	-	-	17
lake whitefish	-	-	-	14	17	-	-
northern pike	6774	4945	3008	1855	5910	5449	4696
muskellunge	78	141	50	42	34	36	-
carp	-	-	9	-	67	45	24
brown bullhead	354	202	205	19	212	55	-
channel catfish	184	70	117	236	514	295	395
white bass	126	143	35	-	43	179	708
rock bass	5601	8587	4422	2119	2978	2952	1667
pumpkinseed	5730	10097	3443	2344	1697	3144	4482
smallmouth bass	9803	11647	10771	6369	6938	10394	1638
largemouth bass	2448	3622	2419	1991	2390	2136	667
black crappie	11673	19348	17160	20243	8794	7348	2757
yellow perch	3393	6720	4461	2461	6961	7442	5519
walleye	1414	1445	1300	744	64	64	45
Total weight caught (kg)*	23201	28119	20570	14735	19357	20549	10477
Total effort (rod-hours)	165058	161804	119596	105402	136821	136530	120134

* Commonly encountered species were weighed by field crews and the means used to calculate each species total weight caught. Other species weights were taken from the mean Ontario or Canadian averages presented in Scott and Crossman (1973).

4. Juveniles to Adults: The fingerling to mature walleye age classes are present each year of sample indicating no significant loss during these stages. A comparison of the mean fork length for all Severn Sound year classes sampled to the Ontario average indicates that Severn Sound walleye are the fastest growing in the province. This is probably due to the high energy input into the system and the large forage base available (Craig, 1983). The majority of male walleye are mature at age 3. Mature females appear in the spawning run at age 3 but the majority join the spawning population at age 4 and virtually all age 5 females are sexually mature.

5. Adults: In July adult walleye appear to move away from the Port Severn area to the deeper waters of the Sound and are sometimes caught in adjacent shallows such as Penetang Bay and Honey harbour. As the summer progresses they "disappear" to "reappear" again outside the Sound in the deeper waters near the Giant's Tomb Island and the Watchers Islands. It is here that the walleye mix with another Eastern Georgian Bay Walleye stock from the Moon River. They remain here through October and into the early winter. A very low percentage of walleye tagged at Port Severn have turned up in other areas of Georgian Bay and very few fish tagged in other locations have appeared in Severn Sound. The Severn Sound and other walleye populations seem faithful to specific spawning sites and other habitats.

Since 1990 population indices have been steadily rising but angler catches have not. The population may be slowly rebuilding. While walleye were declining, black crappie numbers were increasing rapidly. The impacts of the shifting community are unknown but the experiences of Schiavone (1983, 1985) in New York suggest a strong relationship between declining walleye numbers and increasing black crappie.

The age composition of the walleye in 1975 ranged from age 2 to 10+ year old fish (walleye over 10 years of age are difficult to assess using scales and ages are likely underestimated as a result). The presence of highly successful year classes strongly influences the age distribution within a population. The 1969 year class dominated the 1975 population but strong representation was also seen for all ages from 5 to 9. Through the 1980's the relative abundance of all ages declined, especially from 1982 to 1983. Numbers have remained low except for the appearance of a strong 1986 year class. All classes remained represented but in extremely low numbers, suggesting low recruitment until 1986. The first successful stocking of fingerling walleye by volunteer groups also occurred in 1986. By 1992 112,000 fingerlings had been stocked contributing 17% of the ages 2-6 to the population.

Habitat

When habitat is eliminated, the capability of Severn Sound to sustain productive and naturally reproducing fish and wildlife communities is reduced. If the habitat of preferred fish species is destroyed less favourable species often replace them. The loss or destruction of habitat during different life stages could contribute to changes in the fish community structure. Especially susceptible are major predator fish such as northern pike, muskellunge and walleye.

Reduction in wetlands by 68% in Penetanguishene Bay and 18% in Hog Bay between 1951 and 1987 has been documented (Vic Cairns, unpublished data). The remaining wetlands, apart from the protected areas of Matchedash Bay, are susceptible to destruction from shoreline development. An inventory of Severn Sound nearshore habitat is ongoing. Of a total shoreline of 349 KM, 31% is considered essential habitat requiring protection; 4% is considered poor habitat and can be developed; while the remainder is subject to further review and inventory (41%) or is yet to be classified (24%). The management of habitat will be addressed further in Section 4 (see Appendix 2.3).

2.3 Trace Contaminant Status

Sewage plant effluents contribute metals (Canviro, 1988; Marsalek and Ng, 1989; MOE, 1992) especially where significant volumes of industrial wastes are discharged to the sewer system. All sewage plants in the Severn Sound area with the exception of Midland WPCP receive essentially domestic flows with no industries currently generating metal wastes operating. The Town of Midland has several metal plating and electronics industries that generate wastes containing metals. The sludge quality at each plant also reflects these loadings (MOE, unpublished data). Sludge metals concentrations for Severn Sound area sewage plants (Table 2.5) are relatively low (MOE unpublished data) reflecting the predominantly domestic inputs to the plants.

Sludge values for the Penetanguishene Main Street Sewage Plant indicate that cadmium, copper and zinc are elevated in solids relative to Bay sediments. All other metals are at similar levels at or below the levels found in Bay sediments. No unusual source of metals is expected from the plant as it represents typical domestic sewage quality with respect to metals.

Sediment contamination

The quality of sediments in sheltered, deposition areas of Severn Sound represents a legacy of past and current sources of contaminants. Metals have been shown to have a high affinity for fine-grained, organic sediment particles (Forstner, 1987; Forstner and Wittman, 1980). The quality of sediments often reflects the deposition of sediment bound metals resulting from geological and fluvial processes as well as the presence of recent sources.

Table 2.5: Sewage Plant Sludge Quality Data in Severn Sound Area WPCPs, 1990,1991
All units in ug/g unless otherwise indicated.

	Penetanguishene Main St. Module 1		Penetanguishene Main St. Module 2		Penetanguishene Fox St.		Penetanguishene Mental Health Centre		Midland		Port McNicoll		Victoria Harbour		Coldwater	
	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991
arsenic (As)	0.096	0.11	0.09	0.15	0.13	0.13	0.09	0.08	0.20	0.2	0.13	0.2	0.22	0.25	0.04	0.09
cadmium (Cd)	0.082	0.08	0.1	0.097	0.14	0.08	0.15	0.075	0.28	0.2	0.01	0.08	0.16	0.20	0.06	0.08
cobalt (Co)	<0.05	<0.06	<0.05	0.074	<0.05	0.096	<0.05	<0.05	3.9	1.3	0.55	0.16	0.05	0.08	0.10	0.10
chromium (Cr)	2.3	2.84	2.9	3.47	6.1	5.2	7.4	8.55	93.2	66.3	2.36	1.94	4.56	3.73	0.78	1.15
copper (Cu)	7.12	9.5	8.3	10.8	10.5	14.3	15.0	18.07	32.0	34.9	24.3	20.51	20.9	22.88	13.8	19.84
mercury (Hg)	0.07	0.075	0.08	0.08	<0.03	0.028	<0.017	0.05	0.12	0.1	0.43	0.03	0.053	0.03	0.151	0.22
molybedenum (Mo)	0.14	0.18	<0.17	0.18	<0.23	0.18	<0.26	0.23	1.68	1.0	0.73	0.254	0.45	0.38	0.121	0.176
nickel (Ni)	0.29	0.4	0.32	0.49	0.43	0.45	0.24	0.3	77.3	38.5	0.15	0.47	0.65	0.92	0.65	0.74
lead (Pb)	2.5	2.37	2.9	2.64	3.7	2.7	4.6	2.97	18.7	31.7	2.2	1.6	6.0	2.2	1.7	1.9
selenium (Se)	0.07	0.11	0.09	0.11	0.13	0.12	0.13	0.165	0.13	0.1	0.13	0.13	0.19	0.19	0.08	0.13
zinc (Zn)	9.0	12.9	114	15.1	19.3	13.2	12.9	11.6	79.8	105.6	12.6	9.7	22.2	27.9	10.8	16.2
ammonium + nitrate	72.5	33.7	40.0	67.05	66.0	99.2	15.9	29.3	63.7	1573	244.2	253.6	345.4	58.4	173.8	229.2
phosphorus (P)	702	946	856	1131	1298	1403	888	1115	-	-	1330	1081	1716	1404	420	428
solids %	1.77	2.47	2.03	2.77	2.64	2.99	2.13	2.39	-	-	3.04	2.88	3.89	3.87	2.17	2.68
No. of solids	5	6	5	5	5	5	3	2	28	50	3	8	6	6	4	16
Sludge hauled (m3)	3000	3868	-	-	1885	1979	-	-	5077.8	11766.3	1142.4	1146.4	1030.7	376.2	491.4	682.5

The principal sediment deposition zones in Severn Sound are found in the embayments, while in the open Sound, sediment is primarily composed of native clays or coarse materials (Sherman, unpublished data). Surveys conducted in 1988 and 1989 focused on sampling the fine grained materials to determine whether contaminants were present at concentrations sufficient to impair components of the ecosystem. The first phase of the program was to screen sediment to determine whether bulk metal and trace organic contaminants were present at concentrations sufficient to warrant further biological evaluation. The second phase was to conduct more detailed biological tests of toxicity and bioavailability at sites where elevated bulk chemistry warranted further investigation.

The organic content of the sediment in Severn Sound embayments (Table 2.6), especially Penetanguishene Bay, has been enriched as a result of logging and lumbering operations of the late 1800's and early 1900's (Bayfield and Gerow, 1982). Moreover, the sewage plants discharging to the Bay represent a significant source of organic matter that enriches the sediments directly (by depositing suspended solids in the effluent) and indirectly (through effluent nutrients and their stimulating effect on algae growths).

Fine grained sediment in the embayments in Severn Sound contain metals that exceed the Ontario Ministry of the Environment and Energy's Lowest Effect Level, the level at which some disturbance of the sediment-dwelling community can be expected (Table 2.7, Appendix 2.4).
Sediment in Penetanguishene Bay has concentrations of chromium (Cr) that are above the provincial Severe Effect Level, the level at which a compound is expected to be detrimental to the majority of benthic species. Nevertheless, chronic sediment bioassays using juvenile fathead minnow (*Pimephales promelas*), mayfly nymphs (*Hexagenia limbata*) and chironomid larvae (*Chironomus tentans*) resulted in little measurable sublethal toxicity (Krantzberg and Sherman, 1993). Based on evidence from weak acid extraction of metals from sediment, the lack of toxicity may be due to the limited bioavailability of metals.

The potential for metals such as chromium, lead, nickel and mercury to enter the food web was suggested by the bioaccumulation of these elements to concentrations that exceeded those in reference organisms. Chromium and nickel concentrations in mayflies, but not in fathead minnows, were significantly correlated with total chromium and nickel in sediment. The essential elements, zinc and copper were not correlated with total metals in sediment. In general, the bioaccumulation of cadmium, chromium, copper, nickel and lead by fathead minnow and mayflies was more strongly correlated with extractable metals and with metals in the < 63 μm size fraction, respectively, than with metals in bulk sediment. This indicates that the total sediment pool of metals was not biologically available.

Since the sediment bioassays showed little sublethal toxicity, extensive sediment clean up or *in situ* treatment is not warranted. However, since metals in sediment from Severn Sound are potentially available for transfer into the food web, source control and natural sediment recovery are recommended. Confirmation that active sources are not present, and an

Table 2.6: Physical and nutrient characteristics of surficial sediment, 1988,89. (mean values with standard deviation in brackets)

STN #	SAMPLE DEPTH (m)	LOI mg/g d	TOC mg/g d	TKN mg/g d	TP mg/g d	Eh mV	SOLEXT ug/g	TPCB ng/g	%CLAY	%SILT	%SAND
Penetang Bay											
Mean (SD)	5.4 (1.4)	148 (96)	71 (48)	5.24 (1.72)	1.38 (1.07)	-288 (42)	2641 (1688)	31 (31)	5.11 (1.63)	57.7 (22.1)	36.4 (22.8)
Sturgeon Bay											
Mean (SD)	3.6 0.4	84 28	37 (12)	4.04 (1.41)	1.04 (0.06)	-271 (55.6)	907 (435)	20 (0)	4.07 (2.54)	43.8 (13.1)	41.7 (20.5)
Midland Bay and Tiffin Basin											
Mean (SD)	7.3 (1.7)	73 (32)	34 (16)	3.01 (1.25)	0.99 (0.11)	-301 (5.9)	1376 (552)	36 (32)	7.50 (4.12)	63.8 (7.5)	28.0 (10.7)
Honey Harbour (Control)											
HH'87 HH'88		75 46	35 15	3.36 1.6	1.00 0.9				9.93 3.00	73.3 40.0	15.8 57.0

Note: All samples analysed for organochlorine pesticides including DDE - not detected.

LOI = loss on ignition
TOC = total organic carbon
TKN = total Kjeldahl Nitrogen
TP = total phosphorus
Eh = redox potential in millivolts
SOLEXT = solvent extractables (oil & grease)
TPCB = total polychlorinated biphenyls
mg/g d = milligrams per gram dry sediment
ug = micrograms
ng = nanograms

Table 2.7: Bulk metal concentration in surficial sediment, 1988,89. (mean values with standard deviation in brackets, all values in ug/g d.w.)

STN #	Al	As	Cd	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Zn
Penetang Bay											
Mean (SD)	14916 (4769)	3.8 (1.3)	0.83 (0.34)	74 (39)	36 (12)	23028 (5574)	0.21 (0.13)	454 (112)	26 (7.2)	70 (28)	140 (36)
Sturgeon Bay											
Mean (SD)	15862 (4862)	2.9 (1.1)	0.25 (0.16)	37 (10)	14 (5)	23989 (5316)	0.07 (0.04)	536 (142)	18 (6)	20 (7)	82 (29)
Midland Bay and Tiffin Basin											
Mean (SD)	14000 (2000)	2.4 (0.5)	0.32 (0.08)	43 (7)	26 (7)	21600 (1140)	0.12 (0.02)	417 (45)	22 (4)	52 (15)	99 (21)
Reference Honey Harbour and Geological Survey of Canada Data for Regional Lake Sediments											
HH87	19000	4.3	1.10	44	21	31000	0.08	900	25	37	110
HH88	10000	2.1	0.30	22	11	21000	0.02	455	15	20	62
LEL		6	0.6	26	16	20000	0.20	460	16	31	120
SEL		33	10	110	110	40000	2.0	1100	75	250	820
GSC		1	0.66	60.4	20		0.129		14	9	103
(sd)		(1)	(0.34)	(15.8)	(8)		(0.045)		(6)	(10)	(44)

HH = Honey Harbour reference sediment
LEL = Provincial Lowest Effect Level
SEL = Provincial Severe Effect Level
GSC = Geological Survey of Canada lake sediment survey data for Severn Sound Area (Painter, unpublished)

Al = aluminum
As = arsenic
Cd = cadmium
Cr = chromium
Cu = copper
Fe = iron
Hg = mercury
Mn = manganese
Ni = nickel
Pb = lead
Zn = zinc

ability to predict the natural recovery period for marginally contaminated regions would assist in fully restoring the Sound.

Fish Contaminants

Biomonitoring for active sources of mercury was conducted in 1987 using young-of-the-year spottail shiners (data of Suns and Hitchin, Severn Sound RAP, 1988). Spottail shiner residues ranged between 11 and 40 ng/g wet wt. at sixteen sites throughout Severn Sound (Severn Sound RAP, 1988). Penetanguishene Bay spottail shiners were well within the overall range (11-29 ng/g w.w., 16 ng/g off Main Street WPCP).

PCB residues in the Midland Bay spottail collection (164 ng/g) exceeded the IJC Aquatic Life Guidelines (100 ng/g), and quantifiable accumulations of PCBs were also found in collections from Penetang Bay Tannery Point, Midland WPCP, Grandview Beach and Hog Bay. The remainder of the spottail samples had non-detectable PCB residue levels. Low concentrations of DDE were found in all the collections and near-detection limit residues of hexachlorobenzene in some. Heptachlor, aldrin, mirex, BHC, chlorodane, octachlorostyrene and toxaphene were not detected in any of the shiner collections (Appendix 2.5)

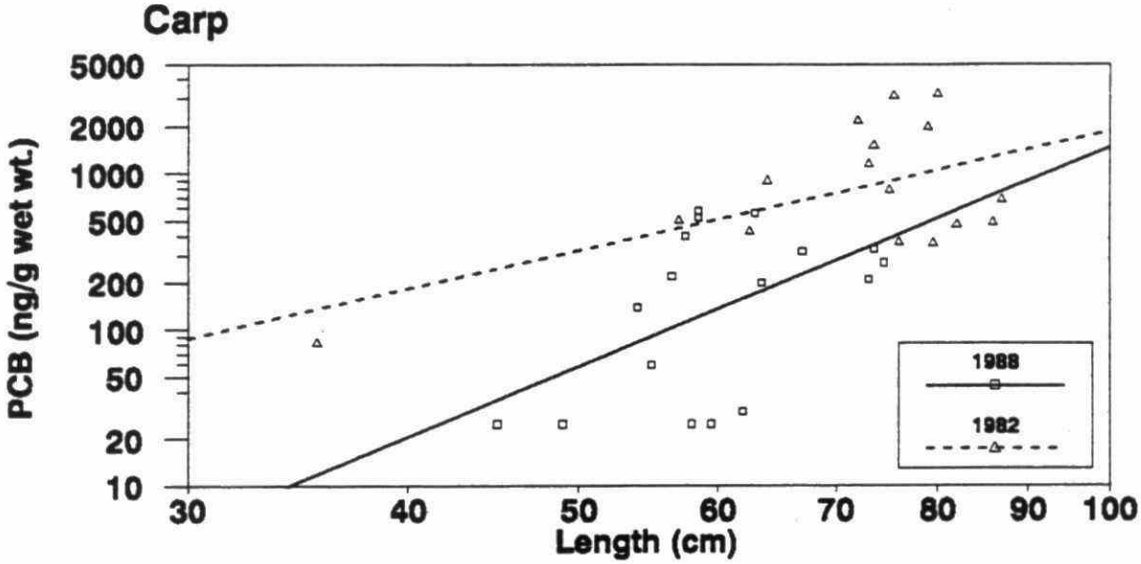
Statistical comparisons of carp samples collected in 1982 and 1988 indicated that PCBs have declined and that many organochlorine pesticides detected in 1982 are nearing non-detectable indicating a reduction in availability (Figure 2.6). Statistical comparisons of walleye samples collected in 1976-77 with those collected in 1989 show a decline in mercury tissue levels, indicating a reduction in the availability of mercury (Figure 2.6). Tests of Rainbow trout and white sucker from Severn Sound in 1989 indicate no restriction in consumption based on PCBs. The reductions in organochlorine pesticides and their breakdown products evident in the carp samples ('82 compared to '88) support the decline in the general presence of these substances. (see Appendix 2.6)

Wildlife Contaminants

Organochlorine contaminants were measured in pooled egg samples of colonial waterbirds, red-winged blackbirds and tree swallows breeding in or near Severn Sound during 1991 (Table 2.8). Breast muscle samples of staging waterfowl were also collected the preceding autumn. PCBs, DDE and mirex were the most prevalent organochlorine contaminants present while oxychlordane, cis-chlordane, dieldrin, heptachlor epoxide, trans-nonachlor, cis-nonachlor, OCS, HCB, beta-HCH were also detectable at low levels in some egg samples. Tetra- and pentachlorobenzene, and alpha- and gamma-HCH were not detected in any of the samples. Generally, contaminant levels in the eggs of herring gulls = Caspian terns > common terns > tree swallows > blackbirds. Concentrations in the eggs of piscivorous birds in the Severn Sound were similar or slightly less than those from colonies in the rest of Georgian Bay and Lake Huron. Mirex levels in herring gulls and caspian terns from

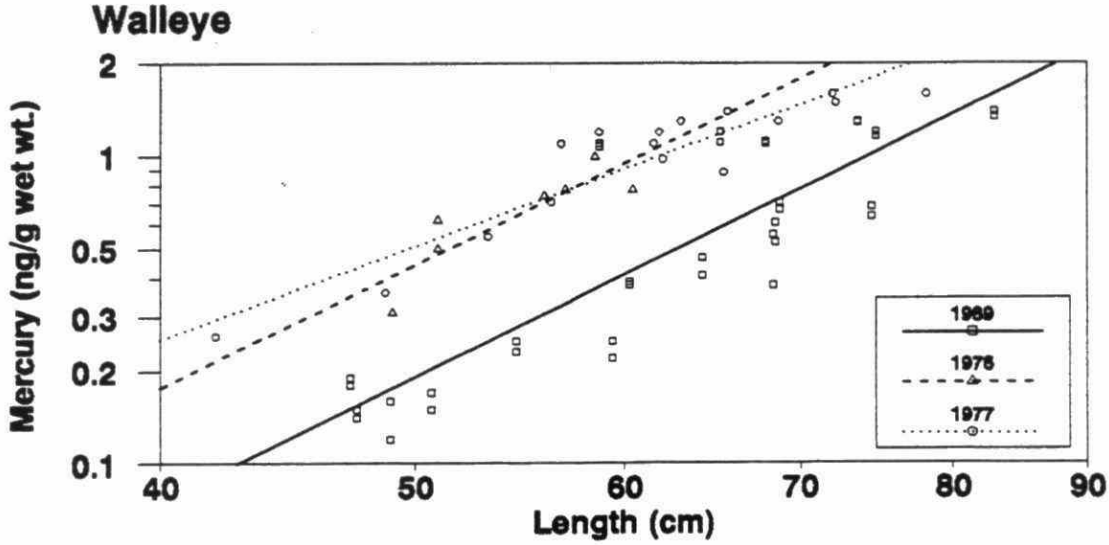
Figure 2.6

Mercury and PCB Concentration vs. Fish Length for Severn Sound Carp and Walleye



1988: Y = X^4.64, r2=0.2649, n=17
1982: Y = 0.0166*X^2.52, r2=0.3269, n=16

Significant difference between years



1989: Y = X^4.19, r2=0.7434, n=36
1976: Y = x^4.14, r2=0.7516, n=7
1977: Y = (2.2*10^-5)X^3.15, r2=0.8502, n=16

No significant difference between 1976,1977
Significant difference between 1976-77 and 1989

Severn Sound colonies were an exception in that they were substantially higher than levels from other Lake Huron colonies, although still much lower than those from Lake Ontario; we cannot discount the possibility that mirex was accumulated by gulls and terns during winter or migrational stopovers on Lake Ontario. Low contaminant levels in common terns may have been a result of their consumption of a smaller size class of prey fish. Higher contaminant levels in tree swallow eggs in comparison to red-winged blackbird eggs may have been due to the preponderance of aquatic insects in their diets as opposed to the larger proportion of terrestrial arthropods in blackbird diets. Only PCBs and DDE were detectable in the breast muscle of lesser scaup and mallards and both were below acceptable levels.

Summary

Based on the above analyses, no apparent active sources of mercury exist within Severn Sound. Nevertheless, mercury contamination of large (old) sport fish persists. This contamination has declined significantly in walleye and is considered to originate from regional geological or atmospheric sources.

Other trace metals show potential to transfer from sediments in deposition areas on the southern bays of Severn Sound into the food web. However, no toxicity of these sediments was noted in sensitive test organisms.

Low but detectable levels of 12 organochlorine contaminants were found in pooled egg samples of piscivorous waterbirds nesting in Severn Sound; ten contaminants were detected in egg pools of passerines breeding in Severn Sound wetlands. In contrast, only DDT metabolites, PCBs and HCB were routinely detected in spottail shiners from Lake Huron, which were being used as a biomonitoring species of local contamination on the Great Lakes (Suns et al. 1991) and low or non-detectable organochlorine contaminants were detectable in Severn Sound sediment samples (Krantzberg and Sherman, 1993). These comparisons suggest that avian species, with their elevated position on the aquatic food web and higher lipid content, probably serve as more sensitive indicators of lipophilic contaminants in wildlife. However, the more localized spottails provide a biomonitor of the presence of localized active sources of contaminants.

Table 2.8: Organochlorine contaminant levels in the eggs of herring gulls (HERG), Caspian terns (CATE)[a], common terns (COTE)[b], red-winged blackbirds (RWBB)[c] and tree swallows (TRSW)[c], and from the breast muscle of lesser scaup (LESC) and mallards (MALL) collected from the Severn Sound area during 1991. Values given as wet weight (mg/kg).

	HERG	CATE	COTE	RWBB	RWBB	RWBB	TRSW	LESC	MALL
Location	Turtle Island	S. Watcher Island	Flat Rock	Wye Marsh	Matchedash Bay	Port Severn	Wye Marsh	Matchedash Bay	Elmvale
c-chlord	0.000	0.012	0.005	NA[d]	NA	NA	NA	ND[e]	ND
O-chlord	0.075	0.052	0.028	0.006	0.012	0.010	0.021	ND	ND
HCB	0.022	0.014	0.015	0.001	0.002	0.002	0.012	ND	ND
OCS	0.009	0.008	0.001	0.0001	0.003	0.0001	0.010	ND	ND
DDE	2.44	3.12	0.83	0.145	0.184	0.118	0.458	0.005	0.002
dieldrin	0.071	0.077	0.065	0.007	0.010	0.003	0.008	ND	ND
HE	0.040	0.038	0.021	0.002	0.003	0.002	0.010	ND	ND
b-HCH	0.001	0.001	0.001	0.0001	0.0001	0.0001	0.004	ND	ND
mirex	0.174	0.167	0.049	0.010	0.007	0.012	0.013	ND	ND
ph-mirex	0.075	0.061	0.020	NA	NA	NA	NA	ND	ND
trans-non	0.038	0.095	0.034	0.005	0.007	0.006	0.007	ND	ND
cis-non	0.024	0.023	0.016	NA	NA	NA	NA	ND	ND
sum PCBs	4.767	5.452	2.124	0.065	0.108	0.082	0.255	0.018	ND

[a] data from Ewins et al. (in prep).
[b] data from Legierse (1991).
[c] data from Chek et al. (in prep).
[d] not analysed for.
[e] not detected.

c-chlor = cis-chlordane
O-chlor = oxy-chlordane
HBC = hexa-chlorobenzene
OCS = octachlorostyrene
DDE = breakdown product of DDT
HE = heptachlor epoxide
b-HCH = beta-hexachlorocyclohexane (lindane)
ph-mirex = photo-mirex
trans-non = trans-nonachlor
cis-non = cis-nonachlor

2.4 Bacterial Contamination

One of the most important uses of Severn Sound is for swimming. A number of sheltered bays around Beausoleil Island (Georgian Bay Islands National Park or GBI) have been considered impaired due to elevated indicator bacteria (Bilyea and Sherman, 1991).

GBI has many small sheltered bays that are popular anchoring and docking sites for a large number of boaters in the Severn Sound area. Swimming is the major use of the 100,000 annual visitors to GBI. Bacteriological analyses of water samples taken by GBI staff suggest that some of these small bays have elevated bacteria that periodically exceed Provincial Water Quality Objectives for swimming and bathing (see Table 2.9 and Figure 2.7). Recently, the indicator organism tested for by the Ontario Ministry of Health laboratory has changed from Fecal coliforms to Escherichia coli (E. coli) in 1992. The Maximum Allowable Concentration of E. coli is 100 counts per 100 ml of test water (MOH, 1992). This change was made by the Ministry of Health as part of the "Beach Management Protocol (Ontario)" for use as a provincial standard and took effect in 1992.

Both Fecal coliforms and Escherichia coli (E. coli) bacteria densities are used as indicators of the presence of fecal matter in the water and therefore the potential for the health risks connected to the pathogens associated with feces. Fecal coliform densities at GBI sampling sites have been related to the number of boats using each site and are not related to rainfall events. Grey and black water discharges and the activities of swimmers from the boats may be contributing to the bacterial contamination of the water (Bilyea and Sherman, 1991).

Following the initial analysis of 1989 data, sampling efforts were focused on four sheltered bays that received heavy boat traffic and the most elevated bacteria counts.

The Ojibway Bay site consistently exceeds PWQOs in July and August until 1992 when E. coli results only exceeded the Maximum Allowable Concentration in late May early June. Lost Bay appears to follow a similar pattern. Both Frying Pan Bay North and South often had bacteria levels which exceeded the PWQOs over the summer sampling periods in 1990 and 1991 but never had values exceeding the Maximum Allowable Concentration in 1992.

Although it would appear that the bacterial contamination of the water in the small bays around GBI is decreasing and subsequently the water quality improving, it will be necessary to obtain more E. coli data to be sure the differences noted are not simply due to a change in the indicator bacteria.

Numerous swimming areas are located along the south shores of Severn Sound. According to the Simcoe County Health Unit, these areas all have acceptable bathing quality. Occasionally, precautionary closings of beaches in Midland Bay have resulted from sewage bypassing events from the Midland WPCP. Monthly geometric mean bacteria counts (Fecal Coliform) occasionally exceeded 100 organisms/100 ml.

Other factors included in the quality assessment of a bathing area (MOH, 1992) include swimming safety, the potential for discharges such as storm water overflows of untreated sewage, and the presence of objectionable deposits or scums caused often in Severn Sound by nuisance growths of algae. Swimming is not safe due to poor visibility in Penetanguishene Bay. Moreover, nuisance algae growths interfere with aesthetic quality of swimming areas in most of the South Shore Bays during the season, especially in Penetanguishene Bay (Table 2.9)

Table 2.9: The Status of Public Swimming Areas in Severn Sound.

STATUS OF PUBLIC SWIMMING AREAS IN SEVERN SOUND											
	#	Beach Name	Bacterial Water Quality (Number of months the Geometric Mean Fecal Coliform (FC) exceeded 100 counts/100 mL)						Aesthetic Concerns (Chl. a)	Safety Concerns (Secchi disk depth)	Other Concerns
			1987	1988	1989	1990	1991	* 1992			
Georgian Bay	1	Kettles Beach									
	2	Sawlog Point									
	3	Crescentwood Beach									
	4	Clearwater Beach									
Outer Harbour	5	Marygrove (camp)	+	+♠	+	+♣			◙		
	6	Coutnac Beach							◙		
	7	Mental Health Centre	+	+	+	+	+	+	◙		§
Penetang Bay	8	Peek-a-boo trail							◙		§,▓
	9	Picottes Beach							◙		§,▓
	10	Michaud Point							◙		§,▓
	11	Penetanguishene Beach							◙		§,▓
	12	Scott St. Park	+♣	+	+	+♠	+♣♠	+	◙	○	§,▓
	13	Huronia Park	+	+	+♠	+	+	+	◙	○	§,▓
	14	Bayfield Park	+	+	+	+♠	+♣	+	◙	○	§,▓
Midland Bay	15	Polish Road	+	+	+	+	+		◙		
	16	Robert St.	+	+	+	+	+		◙		
	17	Camp Simpresca	+	+	+	+♣♠	+		◙		
	18	Curry Road	+	+	+♣♠	+	+		◘		
	19	Puddicombe Road	+	+	+	+	+		◘		
	20	Gawley Park	+	+	+	+	+♣		◘		§
	21	Peterson Park						+	◘		§
	22	Midland Bay							◘		§
	23	Ogdens Beach							◘		
	24	Grandview Beach	+♦♠	+♠	+	+	+		◘		
	25	Patterson Park	+♦	+♠	+	+	+	+	◘		

STATUS OF PUBLIC SWIMMING AREAS IN SEVERN SOUND

	#	Beach Name	Bacterial Water Quality (Number of months the Geometric Mean Fecal Coliform (FC) exceeded 100 counts/100 mL)						Aesthetic Concerns (Chl. a)	Safety Concerns (Secchi disk depth)	Other Concerns
			1987	1988	1989	1990	1991	* 1992			
Hog Bay	26	GFC Trailer Park	+ ♦ ♣ ♠	+ ♣ ♠	+ ♠	+ ♠	+		◙	○	
	27	McKenzie Park	+ ♦ ♣ ♠	+ ♠	+	+ ♣	+ ♦	+ ♠	◙	○	
	28	Crystal Beach							◙	○	
	29	Sunset Beach							◙	○	
Sturgeon Bay	30	Caswells Beach									§,¶
	31	Strugeon Beach									§,¶
	32	Camp Neekaunis	+	+ ♣ ♠	+	+ ♣ ♠	+				§,¶
	33	Waubaushene	+	+ ♦	+	+ ♠	+	+			
Beausoleil Island (inner)	34	Wolverine Beach							◙		
	35	Centennial Island			+	+	+	+	◙		
	36	Cruiser			+	+	+	+	◙		
	37	Toby			+	+	+	+	◙		
	38	Thumb Point			+	+	+	+	◙		
	39	Touch South			+	+	+	+	◙		
	40	Wana Keta			+	+1	+ ♣	+	◙		
	41	Sandpiper			+	+	+	+	◙		
	42	MaCabbe Dock			+	+	+	+	◙		
	43	Ojibway Bay	+	+	+	+1	+ ♣ ♠	+	◙		
	44	Oaks Campground			+	+	+	+	◙		
	45	Chimney Bay	+	+	+	+	+	+	◙		
	46	Blueberry Point			+	+	+	+	◙		
	47	Little Dog		+	+	+	+	+	◙		
	48	Godettes			+	+	+	+	◙		
	49	Cherry Point			+	+1	+ ♦	+	◙		
	50	Frying Pan Bay South		+	+	+1	+ ♣ ♠	+	◙		
	51	Frying Pan Bay North	+		+	+1	+ ♣ ♠	+	◙		
	52	Honeymoon Bay East			+	+	+	+	◙		
	53	Honeymoon Bay West			+	+	+	+	◙		

STATUS OF PUBLIC SWIMMING AREAS IN SEVERN SOUND

	#	Beach Name	Bacterial Water Quality (Number of months the Geometric Mean Fecal Coliform (FC) exceeded 100 counts/100 mL)						Aesthetic Concerns (Chl. a)	Safety Concerns (Secchi disk depth)	Other Concerns
			1987	1988	1989	1990	1991	* 1992			
Beausoleil Island (outer)	54	Lost Bay	+		+	+	+♠	+			
	55	Bass Rock			+	+	+	+			
	56	Bone Island	+		+	+2	+1	+			
	57	Cedar Springs Camp	+		+	+	+	+			
		Severn Sound Inland Public Swimming Areas									
Bass Lake	58	Provincial Park Beach	+	+	+♠	+♠	+♣	+			
	59	2nd Conc. Beach 3				+	+	+♠			
Orr Lake	60	Flos-Medonte Community Park	+	+	+	+	+	+♠			

* The indicator organism tested for by the Ontario Provincial Health Laboratory changed from Fecal coliform to Escherichia coli as part of the Ontario Ministry of Health 1992 Beach Management Protocol. The maximum allowable concentration of indicator organism remained 100 counts per 100mL of sample.

\+ Those beaches being sampled in the given year by either the local Health Unit staff, Ministry of Natural Resources staff or Parks Canada staff.

♦ June Geometric Mean exceeded 100
♣ July Geometric Mean exceeded 100
♠ August Geomtric Mean Exceede 100

◙ The Mean annual Chlorophyll a (Chl. a) concentration was 5 or greater.

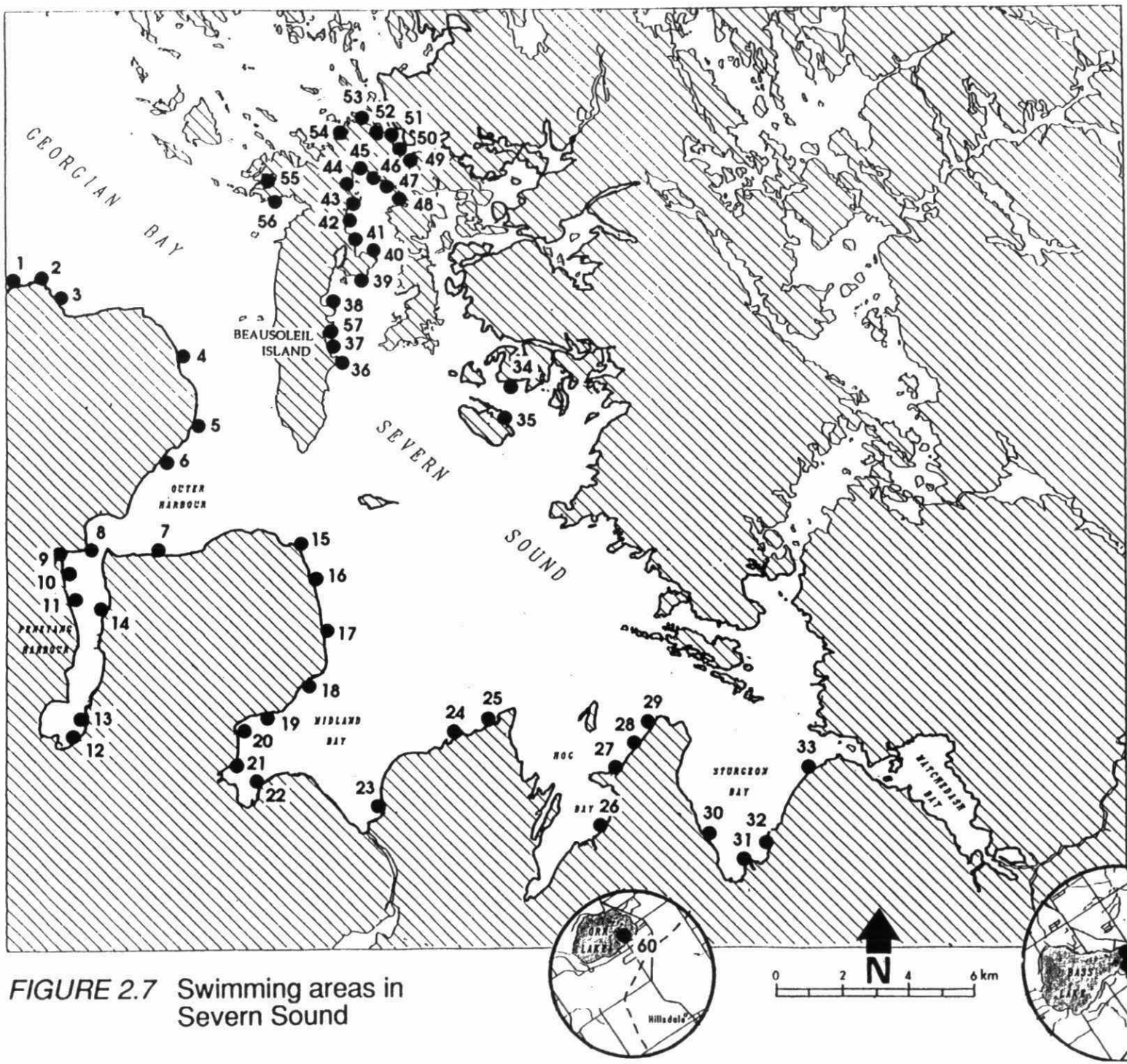
◘ The Mean annual Chlorophyll a (CHL. a) concentration was occassionally 5 or greater, often enough to be considered a threat to bathing water quality.

¤ The Mean annual Secchi Disk Visibility (SDV) was less than 1.2m

§ Sewage Treatment Plant outfall pipe in close proximity to public swimming area

▒ Benthic debris

¶ Dense rooted aquatic plants



GEORGIAN BAY
1 Kettles Beach
2 Sawlog Point
3 Crescentwood Beach
4 Clearwater Beach

OUTER HARBOUR
5 Marygrove (camp)
6 Coutnac Beach
7 Mental Health Centre

PENETANG BAY
8 Peek-a-boo trail
9 Picottes Beach
10 Michaud Point
11 Penetanguishene Beach
12 Scott St. Park
13 Huronia Park
14 Bayfield Park

MIDLAND BAY
15 Polish Road
16 Robert St.
17 Camp Simpresca
18 Curry Road
19 Puddicombe Road
20 Gawley Park
21 Peterson Park
22 Midland Bay
23 Ogdens Beach
24 Grandview Beach
25 Patterson Park

HOG BAY
26 GFC Trailer Park
27 McKenzie Park
28 Crystal Beach
29 Sunset Beach

STURGEON BAY
30 Caswells Beach
31 Sturgeon Beach
32 Camp Neekaunis
33 Waubaushene

BEAUSOLEIL ISLAND (inner)
34 Wolverine Beach
35 Centennial Island
36 Cruiser
37 Toby
38 Thumb Point
39 Touch South
40 Wana Keta
41 Sandpiper
42 MaCabbe Dock
43 Ojibway Bay
44 Oaks Campground
45 Chimney Bay
46 Bluberry Point
47 Little Dog
48 Godettes
49 Cherry Point
50 Frying Pan Bay South
51 Frying Pan Bay North
52 Honeymoon Bay East
53 Honeymoon Bay West

BEAUSOLEIL ISLAND (outer)
54 Lost Bay
55 Bass Rock
56 Bone Island
57 Cedar Springs Camp

BASS LAKE
58 Provincial Park Beach
59 2nd Conc. Beach 3

ORR LAKE
60 Flos-Medonte Community Park

FIGURE 2.7 Swimming areas in Severn Sound

3. USE GOALS AND OBJECTIVES

3.1 Principles

The Severn Sound RAP is being developed following several basic environmental principles. These include:

The Ecosystem Approach - a recognition that everything is interconnected. The living and non living components of the environment, the ecosystem, function and respond together. Activities distant from Severn Sound but within the watershed can have an effect on the Sound. Activities that appear at first to have no connection to the life in the Sound can result in real harm and degradation to aquatic life and the uses that we want to make of the Sound. In practice, when an ecosystem approach is followed, it results in careful study and informed decision making.

Sustainable Development - this is development which meets the needs of the present generation without compromising the ability of the future generations to meet their own needs. Remediating past problems is not enough. Ensuring that further degradation and the creation of future legacies of pollution are prevented through wise planning and stewardship.

Public Involvement - extensive public involvement has been an integral part of the RAP development. The public, including all interested individuals, interest groups and key stakeholders, have been informed about environmental problems and asked for their specific input at several times through the development of the RAP.

3.2 Severn Sound RAP Use Goals

Early in the development of the remedial action plan, a Public Advisory Committee (PAC) was formed to provide public input on the RAP at several key stages.

Much of the first four PAC meetings (starting February, 1989) was devoted to an educational forum with technical and scientific information supplied by the RAP Team. Once informed on water quality standards and the problems within Severn Sound, the PAC set out to develop use goals for the area. The PAC's use goals for Severn Sound are:

GENERAL GOALS

1) ***to improve water quality in Severn Sound***
2) ***to maintain a healthy ecosystem in Severn Sound***

WATER USE GOALS:

1) ***the water should be swimmable virtually everywhere in Severn Sound***
2) ***the fish and water-based wildlife habitats in Severn Sound should be protected to maintain their healthy, naturally reproducing communities***
3) ***the fish from Severn Sound should be edible***

While developing the use goals, the PAC and the RAP Team realized that there are many uses being made of Severn Sound. Rather than deal with establishing goals and objectives related to water quality for each use, the PAC chose to look at the most restrictive uses from a water quality standpoint. The PAC has looked at the implications of the use goals in specific areas such as Penetang Bay. Many of the implications of the use goals for Penetang Bay apply to Severn Sound as a whole. As well, the PAC expressed their concern for the future contribution all tributaries could cause if cooperation was not obtained as factors are identified.

Swimmable Waters

The PAC accepted that swimming is the most difficult use to achieve in terms of water quality. Water which has a quality suitable for swimming is generally suitable for other uses. The concern for swimmers is nuisance algal growth which makes the water murky and unpleasant and occasionally even dangerous for swimmers. The key nutrient that controls algal growth is phosphorus. The sources of phosphorus include controllable sources such as water Pollution Control Plant effluent, agricultural activities in the watershed, marinas and boating activities, dwellings on private septic systems and runoff from surrounding land, and uncontrollable sources such as precipitation (eg. rain and snow). To attain this use goal, loading of phosphorus form controllable sources must be reduced.

However, the PAC also recognized that swimming is not always compatible with other uses. While water should be swimmable virtually everywhere in Severn Sound, it should not be made so at the expense of fish habitat or other recognized uses. For example, areas convenient for swimming need to be free of rooted aquatic plants. Rooted aquatic plants, however, should be maintained elsewhere to support good fish habitat. Other areas also unsuitable for swimming are those influenced by treated sewage effluent, flowing storm sewer discharges, or boat and ship mooring areas.

Habitat Protection

The PAC recognizes that healthy fish and wildlife populations indicate healthy ecosystems. Balanced fish communities help maintain improved water quality and provide fish for harvest. Diverse and abundant wildlife populations indicate low levels of contamination and add to quality of life. Information gaps exist, however, with regard to habitat requirements of many species in Severn Sound. Basic inventories and identification of available habitats are required. Measures are also needed to protect these habitats from adverse shoreline development projects and to enhance habitats where possible.

Edible Fish

The PAC is also concerned about eating fish found in Severn Sound. Some size ranges of some species of fish in Severn Sound have recommended consumption advisories based on mercury and PCB contamination of the fish flesh. The RAP Team has not found any local sources of mercury or PCBs in Severn Sound.

The RAP Team has prepared in this document a set of proposed remedial options to achieve the use goals.

3.3 Delisting Objectives for Severn Sound

The Severn Sound Use Goals were reviewed in relation to the 14 use impairments mentioned in the Great Lakes Water Quality Agreement (GLWQA, Annex 2). Guidance was also provided from the Federal/Provincial RAP Steering Committee as a process for developing delisting Criteria. Specific measurable criteria are needed to determine when use goals have been met and when the beneficial uses have been restored. These criteria are necessary to clearly indicate when Severn Sound can be delisted as an Area of Concern. The principles used in developing the criteria for Severn Sound are as follows:

1. All available international, federal and provincial goals, criteria, guidelines and objectives that apply to the use impairments identified in Stage 1 of the Severn Sound RAP were reviewed and assembled. These criteria were applied to the RAP delisting objectives on a site-specific basis taking into account the local natural conditions and the quality required for the use. For example, the open water phosphorus objective for Severn Sound was established using the MOE guideline of 10-20 ug/L (PWQO/G, MOE, 1984) rather than the IJC open water Georgian Bay target of 6 ug/L (GLWQA) as the former was more appropriate for an embayment flowing into Georgian Bay.
2. Consideration was given to natural, socio-economic, or geographic factors that preclude the full restoration of some uses. For example, it may not be possible to remove advisories for the consumption of Severn Sound sport fish based on mercury

contamination because the sources of mercury are of a lake-wide nature and do not result from specific controllable sources from within Severn Sound. Dissolved oxygen in the bottom waters of restricted subbasins of the Sound (eg. South Bay) may be depleted simply because of the restricted nature of the basin rather than a human induced depletion.

Potential Delisting Objectives for the Severn Sound RAP Use Goals

The available Provincial and Federal guidelines, objectives and standards have been reviewed with respect to the Severn Sound Water Use Goals and are summarized below as potential delisting objectives (measurements used to indicate when the goal has been reached).

WATER USE GOAL

1. ***The water should be swimmable virtually everywhere in Severn Sound***

USE IMPAIRMENT

- Bacteriological pollution of swimming areas with fecal matter or untreated sewage
- Aesthetic and allergic problems associated with nuisance algal growths
- Pollution sources such as sewage plants, storm sewers and streams flow into the bays bringing higher levels of bacteria near the discharge. Swimming is not recommended at these outlets.
- Sometimes enjoyable swimming can be ruined by natural pests such as leeches or swimmer's itch. These pests have little or nothing to do with water quality problems but are a natural part of the water environment.

DELISTING OBJECTIVES

- Total phosphorus concentration that limits the growth of algae should be no more than 10-20 ug/L.*
- Algae density, as indicated by chlorophyll a concentration, should be no more than 5-10 ug/L.**
- E. coli indicator bacteria should have a mean density of no more than 100/100 ml.+
- Water clarity, as indicated by Secchi disc visibility, should be greater than 1.2 m.*
- Water used for swimming should be aesthetically pleasing. The water should be devoid of debris, oil, scum and any substance which produces an objectionable deposit, colour, odour, taste or turbidity.*+
- Rooted or floating plants which could entangle bathers should be absent; very dense growths could affect other activities such as boating and fishing.***

WATER USE GOAL

2. Fish and water-based wildlife habitats in Severn Sound should be protected to maintain their healthy, naturally reproducing communities.

USE IMPAIRMENT

- o A decline in the predator fish such as walleye in Severn Sound may be the result of water quality problems.
- o An increase in the black crappie may also be a result of nutrient enrichment problems.
- o The loss or destruction of habitat during different life stages could also contribute to changes in the fish and water-based wildlife communities. The changes could also influence the water fleas that keep the algae in balance and ultimately the health of the sport fish such as walleye.

DELISTING OBJECTIVES

- Return walleye fishery in Severn Sound to 1970's level.
- Identify habitat areas for protection of fish and wildlife.++

\+ Ontario Ministry of Health. 1992. "Beach Management Guidelines".

* Ontario Ministry of the Environment. 1984. "Water Management: Goals, Policies, Objectives & Implementation Procedures".

** Severn Sound RAP Objective

*** Canadian Council of Resource & Environment Ministers. 1987. "Canadian Water Quality Guidelines".

++ Ministry of Natural Resources District fisheries objective

WATER USE GOAL

3. ***The fish from Severn Sound should be edible.***

USE IMPAIRMENT

- o A consumption advisory has been placed on some large sport fish caught in areas of Severn Sound. The advisory recommends that women of child bearing age and young children not eat walleye greater than 45 cm long, smallmouth bass greater than 35 cm long. Smaller fish of these species can be eaten without restriction by anyone. The restrictions are based on mercury contamination.
- o The restrictions based on mercury are similar to those of other areas of Georgian Bay and may represent a regional level of contamination due to natural geological sources of mercury in the region.

DELISTING OBJECTIVE

- . Mercury concentration in fish flesh should be less than 0.5 ug/g wet wt. for the protection of human health.* This objective must recognize that regional geological and atmospheric sources may be significant sources of mercury to the food chain which may not be augmented by localized sources.

- . Polychlorinated biphenyls (PCBs) concentration in fish flesh should be less than 2 ug/g wet weight for the protection of human health.*

- . Polychlorinated biphenyls (PCBs) concentration in whole fish should not exceed 0.1 ug/g wet weight for the protection of birds and animals that consume fish.**

Further to these potential objectives, the proposed delisting objectives (Table 3.1) were developed in accordance with the COA procedure. As a result of the implementation of the RAP the water quality is expected to improve in Severn Sound. Table 3.2 provides a comparison of existing water quality conditions in the open waters of the Sound to the quality expected once the plan is implemented and delisting has occurred.

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* Ministry of the Environment & Ministry of Natural Resources. 1992. "Guide to Eating Ontario Sport Fish".

** Great Lakes Water Quality Agreement as amended 1987.

TABLE 3.1
OBJECTIVES FOR DELISTING SEVERN SOUND AS AN AREA OF CONCERN

USE IMPAIRMENT	DELISTING OBJECTIVE	RATIONALE	STATUS FOR STAGE 2	HAS OBJECTIVE BEEN ACHEIVED
i) Fish and wildlife consumption.	To have no restrictions on consumption of fish and wildlife from the Severn Sound attributable to local contaminant sources.	Fish consumption guidelines for mercury (MOE/MNR, 1992)	Presently, walleye (>55cm), smallmouth bass (>35cm) and northern pike (>75cm) have mercury contamination and carp has residual organic contamination (MOE & MNR, 1992). DDE, HCB, dieldrin and PCBs have been found in eggs analyzed from red-winged blackbirds, herring gulls, caspian and common terns (CWS & MNR, 1991). To date, no advisories on duck meat consumption have been issued by Health and Welfare Canada.	YES continued monitoring required
ii) Tainting of fish and wildlife flavour.	To continue to have no tainting of fish and wildlife.	Absence of potential tainting substances and no reports of off flavours in fish or water supplies	Survey results continue to confirm no tainting. No known history of tainting substances.	YES
iii) Degradation of fish and wildlife populations.	1. To protect and rehabilitate fish and wildlife habitat.	1. See Use Impairment (xiv)		NO
	2. To restore a balanced self-sustaining fish community* by restoring top-level predators including walleye, northern pike, large and smallmouth bass and muskellunge to levels similar to the early 1970's with these species forming at least 20-30% of the total predator catch, and walleye forming at least 10%. of trapnet results.	2. Based on changes in community noted in late 70's (see Section 2), a return to the proportion of predators found in early 1970's.	2. At present (1992), <10% of total sport fish catch are top-level predator fish with <1% walleye.	YES
	3. To maintain a natural diverse fish community, to discourage the introduction of exotic species and to prevent the extinction of native or desirable species.	3. High diversity is a common indication of ecosystem health.	3. Rich diversity exists with 65 fish species identified in the Severn Sound. There is no indication that diversity is being threatened by factors related to environmental quality. However, introduced exotic species may adversly alter the fish community.	
	* Research continues on the fish community in Severn Sound and other areas of the Great Lakes that may result in more appropriate objectives. The above objectives should be considered interim averages. Natural ecosystem fluctuations may alter actual catch from year to year.			

TABLE 3.1
OBJECTIVES FOR DELISTING SEVERN SOUND AS AN AREA OF CONCERN

USE IMPAIRMENT	DELISTING OBJECTIVE	RATIONALE	STATUS FOR STAGE 2	HAS OBJECTIVE BEEN ACHEIVED
iii) Degradation of fish and wildlife populations continued.	4. To maintain a self sustaining diverse community of colonial waterbirds which currently nest in and near the Sound.	4. Present community is considered diverse.	4. Severn Sound area has a diverse self- sustaining colonial waterbird community including Herring Gulls, Ring Billed Gulls, Caspian terns, Common terns, Double-Crested Cormorants, Black Crowned Night Herons and Great Blue Herons. Management of colonial waterbirds is experimental and achieving specific populations of particular species is highly speculative.	YES
	5. As part of the Matchedash Bay project of the North American Waterfowl Management Plan (NAWMP) to produce 2450 waterfowl including 880 Mallard, 210 Black Duck and 1360 other waterfowl of various species (NAWCC, 1991)[1].	5. Methods under development by MNR (NAWCC, 1991).	5. In progress.	NO
	6. Wildlife populations will be maintained at levels sufficient to provide recreational and economic benefits, ensure environmental quality and ecosystem integrity and ensure public safety (MNR Land Use Guidelines).	6. Methods under development by MNR.	6. In progress.	NO (untill methods developed)
	7. To re-introduce a self sustained population of Trumpeter Swans in the Severn Sound area.	7. As a rare species in North America once present in Severn Sound area, special efforts to reintroduce this species are being made.	7. 17 birds at Wye Marsh in 1992 with a dispersal occuring to Hog and Matchedash Bay in the fall.	NO
	8. To find no significant toxicity from water column or sediment contaminants in fish and wildlife bioassays.	8. Testing of sensitive species may reveal the presence of toxic factors not previously measured.	8. Sewage plant effluents toxic due to chlorine and ammonia (MOE, 1992). No sediment toxicity.	NO
iv&v) Tumours or other deformities in fish & wildlife.	To maintain the low incidence of tumours and other deformities	Low incidence of deformities noted in Double-Crested Cormorants (CWS)	Severn Sound is considered an unimpacted reference site with respect to tumours and other deformities (CWS & MNR, 1990).	YES

[1] NAWCC = North American Wetlands Conservation Council

TABLE 3.1
OBJECTIVES FOR DELISTING SEVERN SOUND AS AN AREA OF CONCERN

USE IMPAIRMENT	DELISTING OBJECTIVE	RATIONALE	STATUS FOR STAGE 2	HAS OBJECTIVE BEEN ACHEIVED
vi) Degradation of benthos.	1. To reach appropriate benthic community targets and ecosystem objectives for Severn Sound.	1. Ecosystem Objectives Working Group Studies and other general benthos studies (Barton 1981;1983; Speller and Pope, 1989).	1. Ongoing.	NO
	2. For the interim, to have benthos characteristic of mesotrophic conditions throughout Severn Sound.	2. Hexagenia used as a sensitive test organism for sediment bioassays (Bedard et al 1992). High densities of L. hoffmeisteri indicate enriched conditions.	2. Assessment of benthos in Penetang and Sturgeon Bay (1980, '82 & '88) indicate eutrophic conditions especially in the southern end of Penetang Bay.	NO
	(a) To maintain and enhance presence of the mayfly Hexagenia as an indicator of ecosystem health.		2.(a) 1990 sediment toxicity tests for mayflies and midge larvae confirm that this objective is currently being met.	YES
	(b) To have a sludge worm density, especially Limnodrilus hoffmeisteri, less than 3,000/m^2 in all locations.		2.(b) Area off Penetang Main Street outfall exceeds density.	NO
	3. Absence of acute and chronic toxic effects on benthos attributable to trace metals or organics in sediments throughout Severn Sound.	3. Bedard et al (1992).		YES
vii) Dredging activities.	To meet biological and chemical guidelines for sediment quality such that there are no restrictions on dredging or disposal activities attributable to polluted sediments.	Provincial Sediment Quality Guidelines (MOE, 1992)	Contaminant levels at some locations may exceed Guidelines due to the fine-grained, nutrient-enriched nature of sediments in embayments. However, no significant toxicity effects noted even at "worst-case" sites. The normal disposal practice for dredged material continues to be dry land disposal with the applicant responsible for assessing the waste quality prior to disposal.	NO
viii) Eutrophication.	See Table A-2 for controllable phosphorus load and concentration targets.		See Figure 2.2 for current levels of phosphorus	NO
ix) Drinking water.	To maintain surface water quality in Severn Sound in order that raw water would only require standard treatment procedures (coagulation, settling, filtration) and that there be no restrictions on consumption or taste and odour problems.	Provincial Drinking Water Objectives (MOE, 199).		YES

TABLE 3.1
OBJECTIVES FOR DELISTING SEVERN SOUND AS AN AREA OF CONCERN

USE IMPAIRMENT	DELISTING OBJECTIVE	RATIONALE	STATUS FOR STAGE 2	HAS OBJECTIVE BEEN ACHEIVED
x) Beach closings.	To meet current provincial objectives for water clarity, pH and bacteria indicator (E.Coli): Geometric mean E. Coli density: <100 org./100ml. Secchi disk visibility: >1.2m Algae densities: <5ug/L (mean ice-free period as chlorophyll)	MOH, 1992 MOE, 1984 Aesthetic complaints about algae generally begin at chlorophyll a concentrations >5ug/L	No health restrictions in swimming areas with the exception of north shore areas that have been closed due to bacteria. Some areas of south shore exceed objectives. Aesthetic impairment due to algae growths at main swimming areas especially in Penetang Bay where safety is also a concern.	NO
xi) Degradation of aesthetics.	Algae density <5 ug/L Chlorophyll a reduces incidence of algae blooms.	MOH, 1992 MOE, 1984 Aesthetic concerns for swimming also relate to objectives for eutrophication.	South shore areas are aesthetically impaired.	NO
xii) Agriculture and Industry.	To have no additional cost for treatment of water for agriculture or industry due to deterioration from contaminant sources in Severn Sound.		Water used for industry and agriculture does not require treatment due to contamination.	YES
xiii) Phytoplankton and zooplankton populations.	To ensure phytoplankton species and biovolume are representative of mesotrophic conditions and to have a balanced zooplankton community. (ie. more daphnia)	Related to fish community objectives (top predator fish).	Large bodied zooplankton are sparse in Severn Sound compared to other Great Lake nearshore areas (especially Daphnia sp.). Exotic species Bythrotrephes may have a negative impact when it becomes established.	NO

TABLE 3.1
OBJECTIVES FOR DELISTING SEVERN SOUND AS AN AREA OF CONCERN

USE IMPAIRMENT	DELISTING OBJECTIVE	RATIONALE	STATUS FOR STAGE 2	HAS OBJECTIVE BEEN ACHEIVED
xiv) Fish and wildlife habitat.	1. To implement the Severn Sound Fish Habitat Management Plan and other policies to enhance and prevent the loss of fish and wildlife habitat	Interim Fish Habitat Management Plan.	1. 107 km or 31% of total shoreline have been identified as requiring protection. 7 wetlands have been classified (MNR files). See also figure 4.?].	NO
	2. To encourage the restoration of fish habitat in target areas by proponents of new shoreline development.	Opportunities during construction may make creation of habitat less costly.	2. 12km of degraded habitat have been targeted in Penetanguishene Bay, Midland Bay and Hog Bay for rehabilitation.(4% of the total shoreline)	NO
	3. To develop plans for rehabilitation or development of new coastal wetland areas as opportunities arise.		3. Matchedash Bay Project of the NAWMP and possibly the recommendations of Tiny-Penetanguishene Committee to develop habitat in southern Penetang and the MTO Highway 69 expansion plan in Port Severn will rehabilitate or create wetland habitat.	
	4. As part of the Matchedash Bay project, to: i) secure and manage 1715 ha of wildlife habitat ii) restore and develop 427 ha of habitat for waterfowl and other wetland dependant wildlife iii) maintain and enhance 442 ha of habitat for staging waterfowl.	Eastern Habitat Joint Venture of the North American Waterfowl Management Plan (NAWMP).	4(i). 1364 ha purchased by 1992 (ii). 50 ha under development in 1992	NO
	5. To rehabilitate tributaries and riparian areas for fish and wildlife habitats.	Cattle access to streams is one of the major problems, resulting in increased nutrient input and habitat destruction.	5. 38 kms of streams with fish habitat that require rehabilitation have been identified, 11km completed, 13ha planted with trees and shrubs.	NO
	6. To maintain existing colonial waterbird nesting sites within and near Severn Sound.		6. Trends suggest populations fluctuate from year to year but appear healthy and self-sustaining.	YES
	7. To maintain and increase Osprey nesting sites within Severn Sound.		7. Existing sites have not been affected by significant human interference. Several artificial nesting structures have been erected by volunteers.	YES

Table 3.2: Expected Open Water Quality Compared to Measured Conditions

		Penetang Bay	Sturgeon Bay	Port Severn	Open Severn Sound
[TP] (ug/L)	E	<20	<15	no increase <15	<15
	M	37	19	13	17
[Chl. a] (ug/L)	E	<5-7	<5	<5	<5
	M	12	2.0	2	6
SDV (m)	E	>2	to bottom	>3	>3
	M	1.5			
Aquatic Plant	E	increase	no change	no change	no change
	M	30%			
Min. D.O. (mg/L)	E	>5	>5	>5	>5
	M	<3	>5	>5	<2

E = Expected
M = Measured

[TP] = Total phosphorus concentration
[Chl. a] = Chlorophyl a concentration
SDV = Secchi disk visibility
Min. D.O. = Minimum dissolved oxygen

4. EVALUATION OF REMEDIAL ACTIONS

The actions necessary to restore environmental quality in Severn Sound have been discussed and studied by the RAP Team and the PAC over the past two years. Wherever possible actions that were clearly necessary were implemented. For example, a survey of private sewage systems was needed to identify and correct family systems. This action was initiated in 1989 with the Severn Sound shoreline pollution survey and will be completed in 1993. Other actions, such as improving sewage treatment plant efficiency, required additional study of the receiving water requirements, treatment technology and costs before the planned action could be detailed for each plant. Some actions (e.g. fish habitat) must be considered interim measures pending results of ongoing research or additional site specific studies.

As clean up is achieved, the improved quality must be sustained into future generations. In some cases this will mean, for example, that caps on loadings of phosphorus to embayments will be necessary or that fragile and unique areas of the nearshore must be protected from development pressures. These actions will require formal and informal agreements by a number of stakeholders to ensure that they are carried out effectively.

Whenever the remedial action required was clear, problems were addressed, even during development of the RAP. Since the Stage 1 was submitted (February 1989) several remedial measures have become obvious and resulted in actions including:

- specific receiving water-based effluent requirements for sewage plant expansions and upgrades
- rehabilitation of eroding stream banks and fish habitat
- correction of sources of phosphorus from farms
- systematic inspections and correction of faulty private sewage systems
- encouraging the development of fish habitat as part of shoreline development proposals where opportunities arose

In other cases the action is more complicated because of a variety of potential approaches or a lack of information necessary to make decisions on appropriate action.

The following recommended actions have resulted from discussions of the remedial options with specific technical experts, interest groups, key stakeholders and the Public Advisory Committee.

1. Improve Sewage Plant Efficiency

A range of actions to reduce the supply of phosphorus from sewage plant effluents and to minimize the effect of the discharges are being considered for existing and future development areas.

a) Optimize the use of existing equipment and treatment.
b) Provide additional treatment where needed.
c) Improve outfall dispersion characteristics.
d) Consolidate plants to combine improved treatment with better discharge location.
e) Store sludge from sewage plants during the period when spreading is not recommended (normally November 30 to April 15).

2. Upgrade Private Sewage Systems

Ensuring that sewage systems serving individual shoreline dwellings are updated and are functioning properly will reduce phosphorus export from these sources. A three year cottage pollution control survey of shoreline dwellings in Severn Sound has been completed to target problem private sewage systems. Owners are responsible for the cost of repair and upkeep of the systems. Research is currently being conducted to improve phosphorus removal efficiency of private sewage systems and may be applied to Severn Sound dwellings.

a) Replace faulty or seriously substandard private sewage systems with properly operating systems according to Environmental Protection Act regulations.
b) Research phosphorus removal efficiency (as well as nitrogen and bacteria) by conventional septic tank and tile field systems on the variable soils expected in Severn Sound.

3. Reduce Storm Water Supply

Methods to control phosphorus supplies from new developments and existing sewered areas would involve settling and retention or slowing of storm water as well as treatment of storm water to remove phosphorus and other pollutants. A solids removal system and a strategy to maintain the natural or pre-development runoff characteristics after development should also be considered to reduce storm water supplies of phosphorus.

a) Virtually eliminate bypass from sewage pumping stations and combined sewer overflows (CSOs) in the Severn Sound area.
b) Retain and treat stormwater runoff in existing catchments where locations allow.
c) Plan all new development proposals to include retention and treatment of stormwater during and after construction.
d) Clearing of land prior to construction must be minimized to retain as much natural vegetation cover as possible.
e) Develop storm water management plans by municipalities in cooperation with provincial agencies in order to incorporate integrated storm water management on a watershed basis.

4. Reduce Agricultural Sources

Several agricultural practices and conditions that contribute phosphorus can be controlled. The dates for specific annual control are included as a guideline to prevent the spreading of manure and sludge at a time when the ground is frozen or saturated and unable to absorb nutrient runoff.

a) Manage runoff from manure storage areas and barnyards.
b) Eliminate the spreading of manure on land from freeze-up of land to when land is workable after spring thaw (usually Nov. 30 - Apr. 15).
c) Eliminate the spreading of sludge (from sewage plants) on land from freeze-up of land to when land is workable after spring thaw (usually Nov. 30 - Apr. 15).
d) Eliminate the spreading of septage (from storage or private sewage systems) at any time.
e) Direct milkhouse waste to treatment.
f) Restrict livestock access to water courses.
g) Encourage conservation tillage, crop rotation and other erosion control practices.

5. Reduce Sources of Erosion

Phosphorus bound to soil particles that erode from the land can runoff into water courses. This phosphorus supply from erosion can be reduced by stabilizing stream banks, restricting livestock from streams and controlling erosion from construction projects.

a) Stabilize banks and plant vegetation buffers along water courses.
b) Minimize erosion during and after road construction and maintenance practices.
c) Restrict the clearing of land prior to and during construction projects.

6. Reduce Supply From Marine Activities

Larger dredging projects and marina construction have a potential to release phosphorus from the sediments and fill material into the water. Pleasure craft sink water (grey water) discharge and illegally dumped sewage (black water) also releases phosphorus to the water. In localized areas grey water phosphorus can be very significant in degrading water quality.

a) Enforce existing pleasure boat black water legislation (EPA Reg. 305 + 310).
b) Encourage onboard storage of pleasure boat grey water.
c) Designate one agency to coordinate the review of all marine construction proposals.
d) Review marine construction proposals under the Interim Fish Habitat Management Plan (see below).
e) Stabilize banks and plant vegetation buffers along water courses.

7. Fish and Wildlife Protection and Improvement

To protect and maintain healthy, naturally reproducing communities of fish and wildlife a number of initiatives are to be taken. Unique and valuable habitat are to be preserved and rehabilitated when necessary and can even be created under certain circumstances. Efforts must also be made to restore a balanced fish community by preventing a decline in large predator fish, such as walleye.

a) Support and incorporate wetlands and other unique and valuable habitat preservation initiatives in proposal review and land use controls in the Severn Sound watershed.
b) Create productive fish and wildlife habitats as specific projects such as the North American Waterfowl Management Plan Eastern Habitat Joint Venture (Matchedash Bay) or as a result of shoreline and marine development.
c) Endorse and implement the Interim Severn Sound Fish Habitat Management Plan (by the Federal Department of Fisheries and Oceans, the Ministry of Natural Resources and the local municipalities).
d) Rehabilitate fish habitat and buffer vegetation of streams flowing directly to Severn Sound.
e) As an interim measure, stock sufficient numbers of fingerling walleye to restore an abundance of larger predator fish to achieve a healthy balanced community.

8. Prevent Contamination

Contaminants include phosphorus toxic substances and harmful bacteria. Although contamination from bacteria and trace metals has not been generally identified as a problem in Severn Sound, potential sources of pollution have been identified and must be monitored to ensure problems do not arise. Industry and individual homes represent another controllable source of phosphorus.

a) Implement the Ministry of the Environment and Energy MISA(*) program, especially the municipal sector, in the Severn Sound area.

b) Encourage water conservation in and around the home and in industrial processes.

c) Encourage the use of safe alternatives to cleaning products containing phosphorus.

d) Encourage a personal and corporate lifestyle that eliminates the creation and disposal of pollutants that could harm or add to the contaminant burden of Severn Sound.

e) Control sources of bacteria by:

- Conducting a "Cottage Pollution Control Survey" of all of Severn Sound.
- Conducting a boating inspection program for Severn Sound.
- Developing and implementing an urban stormwater retention and treatment strategy.
- Encouraging farming practices that minimize the potential for contamination of water by agricultural activities.

f) Monitor to ensure detection of any new sources of contaminants and the decline of existing contaminants especially in fish.

9. Plan Input and Review

The remediation of problems in Severn Sound will be ineffective unless the principles and specific concerns are incorporated into plans and review procedures of planning and resource management agencies to ensure that future growth and development is carried out wisely.

a) Create Official Plan model amendments with RAP objectives for all municipalities within Severn Sound watershed.

b) Develop Storm Water Management Plans for all municipalities within the Severn Sound watershed.

c) Encourage the Ministry of Agriculture and Food to develop farm plans with RAP objectives.

d) Review all marine construction and development proposals under the Interim Fish Habitat Management Plan.

(*) The Municipal/Industrial Strategy for Abatement (MISA) is a major Ontario initiative to reduce water pollution from industrial and municipal dischargers. The ultimate goal is the virtual elimination of persistent toxic contaminants from all discharges in Ontario waterways.

The nine general categories of actions are aimed at eliminating the problems identified in Severn Sound. Prevention of contamination in Severn Sound is also addressed.

The following sections provide a detailed analysis of each recommended action. The first deals with actions to control phosphorus from various sources. The second (section 4.2) reviews the actions to protect and enhance fish and wildlife habitat and to improve the balanced fish community. The third section reviews actions to prevent contamination.

4.1 Actions to Control Phosphorus

4.1.1 Improving Sewage Plant Efficiency

The sewage plants servicing the Towns and Villages in the Severn Sound area are an important, controllable source of phosphorus. Most plants at present provide secondary treatment with phosphorus removal designed to meet an effluent total phosphorus concentration of 1.0 mg/L.

A recent review of proven technologies available to improve phosphorus removal (XCG, 1991a) indicated that with the addition of tertiary treatment or sand filters, an effluent total phosphorus concentration of 0.30 to 0.15 mg/L can be consistently achieved. A much higher degree of treatment may be required to achieve an effluent total phosphorus concentration of 0.10 mg/L or less. All of these scenarios were based on proven technologies that were in place at the time of the review (1990).

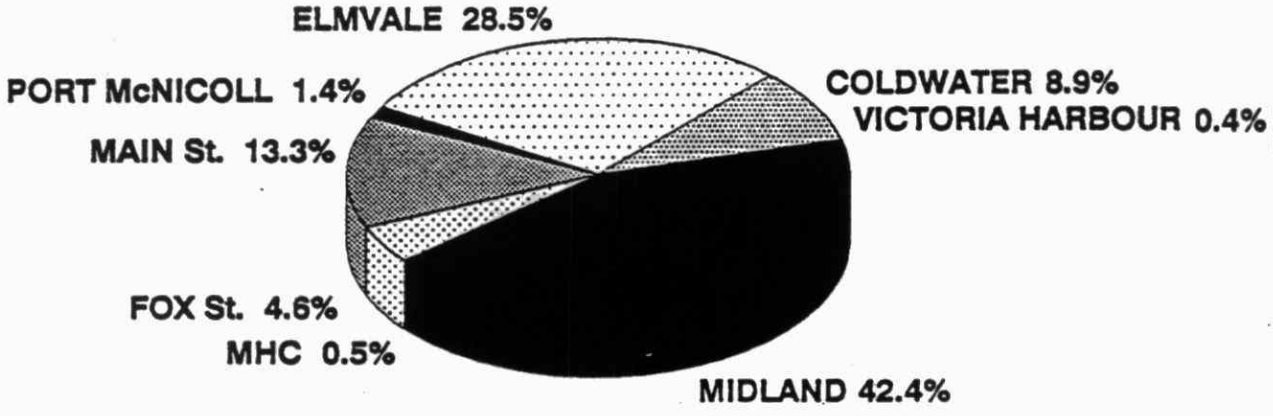
Other methods of achieving low effluent phosphorus concentrations are under investigation (XCG, 1991a) but lack the track record of routine full scale evaluation. It may be possible, for example, to achieve an effluent phosphorus concentration of 0.3 mg/L by optimizing the equipment and operation at an existing secondary sewage plant without expensive upgrades.

The phosphorus removal performance of the eight existing sewage plants in Severn Sound was reviewed (XCG, 1991b). A wide range of performance was noted and was related to equipment and operation. Two plants, Elmvale and Coldwater, presently provide no chemical addition for phosphorus removal. The Penetanguishene Mental Health Centre (MHC) Sewage Plant, a small "package" plant, provides good phosphorus removal with an effluent average of 0.19 mg/L. Victoria Harbour WPCP is the only tertiary treatment plant in the area and provides the lowest effluent phosphorus concentration of 0.13 mg/L.

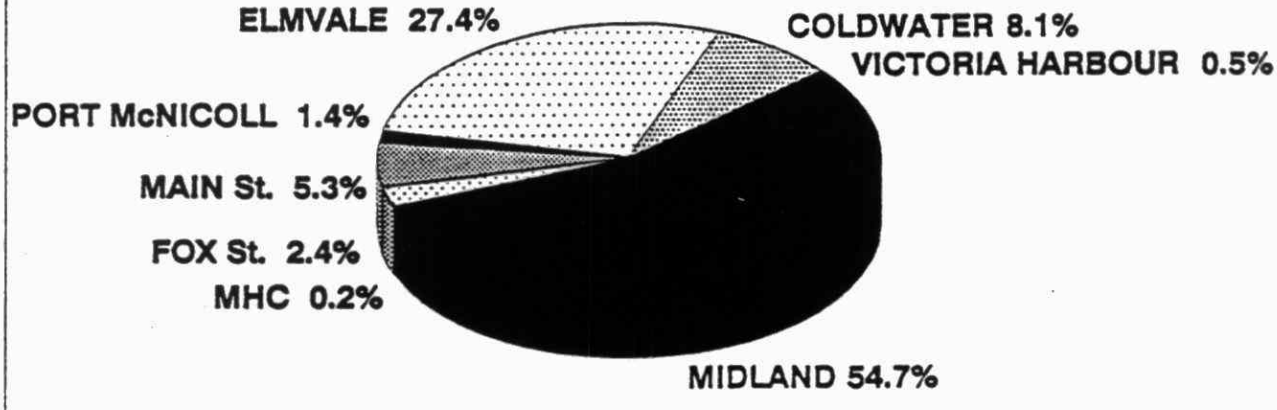
Figure 4.1 illustrates the fraction of the total phosphorus loading to Severn Sound contributed by each of the WPCPs in the area in 1989 and 1990. The Midland WPCP represents about 50 percent of the total. The Midland WPCP also represents about 60 percent of the total treated effluent discharged to Severn Sound. The three Penetanguishene plants (Main St., Fox St., and MHC) contribute about 15% of the total phosphorus loading for this two year period, based on available data. The two plants which do not practice phosphorus removal (Elmvale and Coldwater) contribute a substantial fraction of the total loading considering their relative sizes. About 30 percent of the total loading originated from these two plants which are responsible for only about 10 percent of the total sewage flow. The Elmvale lagoons contribute the largest fraction (28% of the total loading). The Victoria Harbour WPCP, the Port McNicoll WPCP and the Penetang MHC WPCP combined contribute only 2 percent of the total phosphorus loading from nearly 10 percent of the sewage flow.

Figure 4.1:

RELATIVE CONTRIBUTION OF TP FROM INDIVIDUAL WPCPs



1989



1990

A thorough review of the design, operation and performance of the eight WPCPs under review suggests that the estimated annual total phosphorus loading from these facilities (6, 121 kg/yr for 1989-90, and 6,600 kg/yr for 1990) is probably a low estimate of the actual TP loading originating from these plants. Factors which contribute to the higher than reported loading include the following:

i) **Bypass of raw sewage** from the Elmvale collection system to the Wye River are not included in the reported loading. The quantity and frequency of bypassing is not available. However, based on the available flow information and the high concentration of phosphorus reported in the Elmvale raw sewage, the bypass to the Wye River may represent from 25 to 50 percent of the reported phosphorus discharges from the lagoons. Fortunately, a new sewage pumping station installed in 1991 has virtually eliminated this bypassing.

ii) **Overflows** from the collection system serving the Town of Midland are not included in the total reported loading. These overflows can contain elevated concentrations of phosphorus due to discharges from a metal finisher immediately upstream. In addition, the reported flows from the Midland WPCP until recently did not include any flow which bypassed the headworks. Although no data are available regarding the quantity of sewage bypassed from the collection system directly to Midland Bay, it is estimated that the total additional unreported phosphorus loading may represent as much as 10 percent of the reported load.

iii) **Flow metering inaccuracies**, non-representative sampling and the exclusion of plant bypasses in the reported loadings from the Penetang Main St. WPCP were noted during the plant review. These problems may result in the total loading of phosphorus from the Main St. plant being underestimated by as much as 100 percent. Flow metering inaccuracies were also identified at the Fox St. WPCP. Although no data are available to assess the representativeness of sampling procedures, identified problems at the Main St. plant raise concerns regarding the procedures at Fox St. The estimated TP loadings from this facility may be low by as much as 50 percent.

iv) **Drainage from the sludge drying beds** at the Penetanguishene MHC WPCP until recently, entered Penetanguishene Bay. This probably represents a relatively small unreported loading of phosphorus to the Bay.

All of these factors will serve to increase the actual loading to the Sound compared to the calculation based on the plant flow and effluent concentration data. The additional loading may be as much as 25 percent of that reported or about 1500 kg/year. As much as 400 kg of unreported phosphorus may be entering Penetang Bay from the Penetang WPCPs.

With the exception of the Penetanguishene MHC plant and the Victoria Harbour WPCP, all the plants are near or at design average flows and require expansion before additional serviced development can proceed. The growth potential for each plant must be taken into account when deciding on the effluent requirement because the load or supply from the plant, not just the effluent concentrations, impact the receiving water quality. Based on the receiving water constraints, the technology available and the growth expected in the plants, a near term objective for effluent concentrations and load was derived that would meet the open water quality targets for Severn Sound and the immediate receiving water (Table 4.1).

Table 4.1 Evaluation of effluent targets for Severn Sound area sewage plants

Plant	Present Pop'n Serviced	Present Design Flow (m3/d)	Present Effluent [TP]* (mg/L)	Present Phosphorus Load** (kg/y)	Target Effluent [TP] (mg/L)	Forecast Design Flow (m3/d)	P.Load with Upgrade (kg/y)	Reduction in P. Supply (%)(6)
Penetanguishene Bay								
Main St.	4,300	3,000	0.58	552	0.10	4546 (1)	166	70
Fox St.	1,000	1,500	0.47	215	0.10	1515 (1)	55	74
Open Severn Sound								
Penetang MHC	950	568	0.19	39	0.19	568 (2)	39	0
Midland	12,000	13,638	0.72	2,944	0.30	18,180 (3)	1,992	32
Port McNicoll	1,800	1,045	0.32	88	0.30	2000 (3)	219	0(-150)
Wye River								
Elmvale	1,200	750	3.5	1,750	0.10	1512 (4)	55	97
Sturgeon Bay								
Victoria Harbour	1,669	2,363	0.12	27	0.15	2363 (5)	129	-378
Port Severn Area/Matchedash Bay								
Coldwater	796	545	3.55	526	0.30	1000 (3)	110	79
Totals	23,715	23,409		6,121		28,504	2,398	61

Possible new service area includes Port Severn (to serve pop. 3669; 1650 m^3/d; 0.3 mg/L; 181 kg/yr; Paragon Engineering Ltd., 1992)
* 1989-90 Effluent Quality, reported to the MOE, (XCG, 1991b)
** 1989-90 (XCG, 1991b)

Notes on forecast design flows:
(1) Reid and Associates on behalf of Town of Penetanguishene (1992).
(2) Penetanguishene Mental Health Centre flow and quality assumed to remain the same.
(3) Assumed increase in design flow capacity
(4) Ainley and Associates on behalf of the Village of Elmvale (Class EA Design brief, 1991)
(5) Growth assumed to take up existing design flow capacity
(6) Compares existing load with P.Load after upgrade at forecast design flow

4.1.2 Upgrade Private Sewage Systems

The phosphorus supply from private shoreline sewage systems depends first on the operating condition of the system and then on the ability of the soils used in the tile bed and the soil cover between the tile field and the water.

The Shoreline Pollution Survey of Severn Sound to date has indicated that 20% of the systems inspected were seriously substandard (Table 4.2). Abatement is proceeding on the correction of the systems needing work. This will result in a reduction in phosphorus entering the Sound as well as reduce the potential for bacterial contamination of nearshore waters.

The shoreline systems in Severn Sound will have been inspected and abatement will be substantially complete by MOEE and Health Unit staff during 1993. However, the systems inspected and found satisfactory could fail in years after the inspections. The land owner must maintain the system and ensure that it is functioning properly. **Private sewage systems should be inspected every three years.** Part of the inspection and maintenance of private sewage systems involves the pumpout of septage and holding tank waste. This waste must be pumped out by a licensed hauler and disposed of according to provincial policy. It is preferable that the waste be disposed of at a sewage treatment plant that has been properly equipped to receive the waste. Spreading of septage and holding waste on land is presently an option. However, the RAP recommends that this practice be discontinued in the Severn Sound watershed. (See section 4.1.4)

Soil conditions on the North Shore of Severn Sound and parts of the Southeast end are thin and coarse over bedrock. Septic tank and tile bed installation generally requires additional fill to meet MOEE regulations. The south shore has better soil cover with increased potential for phosphorus retention. There is a wide range of opinion in scientific literature on the phosphorus retention provided by a properly installed and operated septic tank and tile bed (Dillon et al. , 1986). Research is continuing on the retention provided both by the tile field and by the vegetation and soil cover between the system and the shoreline. Improvement in nutrient removal efficiency of the private sewage systems has also been studied (Dillon et al., 1992).

Direct measurement of the capacity of the natural soil to retain phosphorus from private sewage disposal systems is very difficult because of the long time required for the phosphorus to reach the shoreline.

The average per capita phosphorus contributed in a domestic dwelling is 0.8 Kg/yr from a combination of sources (including sewage and wash water). Assuming 2.5 people per dwelling, the average phosphorus supply from a dwelling used year round could range from 0.4 to 2.0 Kg/yr. With some 3000 shoreline dwellings, this could mean 1,200 to 6,000 Kg/yr entering Severn Sound from this source.

In addition to sewage and washwater, phosphorus is also contributed from those shoreline properties where fertilizer is used to enhance lawn growth. The actual amount of phosphorus from the original fertilizer applied will depend on the soil conditions, slope and the natural vegetative buffer between the lawn and the shoreline. All of these factors depend on the personal choices made by the land owner in how the shoreline property is managed.

Table 4.2: Classification of Shoreline Sewage Systems in Severn Sound, 1990,1991

BODY OF WATER	# OF SYSTEMS INSPECTED	CLASSIFICATION OF SYSTEMS															
		Satisfactory		Satisfactory Performance		Seriously Substandard		Nuisance - Wash Water		Nuisance - Solid Waste		Direct Polluter		Unclassified Temporarily		Unclassified	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Severn Sound - Simcoe	530	9	2	367	69	83	16	15	3	38	7	0	0	18	3	0	0
Severn Sound - Muskoka	1139	64	6	558	49	259	23	68	6	171	15	1	0	17	1	1	0
Penetang	473	42	9	253	54	97	21	16	3	39	8	0	0	23	5	3	1
TOTALS	2142	115	5	1178	55	439	20	99	5	248	12	1	0	58	3	1	0

"Satisfactory" = proper size and function
"Satisfactory Performance" = may be smaller size but functioning
"Seriously substandard" = does not meet Ministry regulations
"Nuisance - washwater" = discharge of washwater (laundry) to the ground which can runoff
"Nuisance - solid waste" = improper disposal of garbage on property
"Direct polluter" = sewage is discharged directly to the ground or the water body
"Unclassified Temporarily" = unable to confirm the system in use at the time of the survey
"Unclassified" = unable to confirm the system after repeated attempts

Source: Ministry of the Enviroment, Central Region, 1990-91 shoreline sewage system inspection results

4.1.3 Controlling Urban Storm Water

The goal of the MOEE/MNR Interim Stormwater Quality Control Guidelines (MOE/MNR, 1991) is the " protection and enhancement of pre-development hydrologic and water quality regimes". Traditional urban development is designed to direct stormwater to surface waters in order to protect against the loss of both property and life due to flooding and erosion. In addition, undesirable effects result in:

- increased surface runoff volumes and peak flows;
- decreased base flows and groundwater input;
- increased pollutant export from serviced areas;
- increased surface water temperatures.

Urban storm water is a controllable source of phosphorus which drains from the proportionately small urban area within the Severn Sound watershed (34 km^2, 3% of the total watershed area). Storm water is also a known source of bacteria and trace contaminants.

Three aspects of stormwater management and quality control were considered in Severn Sound.

1. The occasional overflow or bypass of raw sewage from sewage pumping stations into storm sewers.
2. The stormwater runoff from existing built up areas.
3. The stormwater runoff from new areas of development during and after construction.

Bypassing and Combined Sewer Overflows

In urban areas serviced by communal sewage plants, pumping stations function to pump sewage at points in the collecting sewers toward the plant. When the pumps can't handle the flow received (due to storm water input or due to changes in the collection system) or when power outages or equipment failure occur, sewage collects at the pumping station and overflows generally to a storm sewer that drains to a local stream or bay. The overflow results in the discharge of raw untreated sewage, normally mixed with rainwater, to the receiving water. Bypassing of sewage can also occur from different stages of treatment at the sewage plants and normally discharges to the outfall.

Design of new plant upgrades and expansions normally include consideration of pumping station size and equipment to ensure that fluctuations in flows can be handled to virtually eliminate bypassing. In addition, standby electrical power eliminates bypassing due to power outages.

The recent status of pumping stations with known bypassing to Severn Sound is summarized as follows:

1. Midland
   Two of four pumping stations experience occasional bypassing. A study by the Town recommends upgrading the pumping stations with variable speed pumps and standby power. The upgrading of these two stations would virtually eliminate bypass from the pumping stations to Midland Bay. Expected reduction in phosphorus input would be up to 10% of the reported sewage plant load (290 kg/yr).

2. Elmvale
   The main pumping station was frequently bypassing but has recently been replaced. The new station has standby power and will virtually eliminate bypassing. Expected reduction in bypassing to the Wye River may be as high as 50 % of the existing phosphorus load from the lagoons (875 kg/yr).

3. Penetanguishene Main St. and Fox St. Plants
   The main pumping station at Main St. WPCP will be upgraded with the plant and should virtually eliminate bypassing. Estimated bypass from the plant and the main pumping station was 51 kg/yr during 1990 (XCG, 1991b).

A small length of combined sewers (sewers that receive storm runoff as well as sewage) are present in two locations in Midland. These combine sewers have an overflow (CSO) just ahead of the pumping stations in the sewage collection system. Overflows occur occasionally due to heavy rain events. The area drained by these sewers is small relative to the total urban area in the Town of Midland (5 km^2 or $<10\%$).

Existing Urban Storm Water Runoff

Once established, a major effort may be required to retrofit storm water treatment into existing urban areas.

Dry weather flows can include sewage connections discharges to storm sewers. Once these are noted and corrected dry weather flow should consist largely of clean ground water drainage. Storm events generate the main loading concern from the relatively small urban centres of Severn Sound.

There are four principle considerations in the control of storm runoff (MOE/MNR, 1991).

1. Initial storm runoff is typically high in pollutants accumulated during antecedent dry periods.
2. Control must minimize the contamination of storm runoff at the source.
3. Control must reduce the volume of storm runoff moving off site.
4. Control must take into account not only runoff volume but also the frequency and duration of runoff events.

New Urban Storm Water Runoff

All new development proposals should include a plan for managing storm water during construction and after construction. The Storm Water Quality Control Guidelines (MNR and MOE, 1991) summarize the concerns that should be addressed. Planning for urban areas should also be done to include the land in urban subwatersheds to ensure that comprehensive quality control is achieved as new developments come into an area. As an interim target, it should be possible to reduce phosphorus from storm water by 20%.

The estimate of storm water from the urban areas of Severn Sound both existing and potential is 3,133 kg/yr. Both the best management practices for stormwater treatment and the costs are under study for RAP areas. Preliminary cost estimates (Hickling, 1992) indicate that treatment of storm water from existing and proposed catchments will be very expensive as compared to costs for control of other sources. An additional (probably very much cheaper) action that would reduce phosphorus export from urban areas is to carefully control the stripping and vegetation growing on vacant and other green space to maximize the retention of storm water and minimize the export of phosphorus. Returning as much of the urban land as possible, especially on steep slopes and shoreline, to forest would result in a reduction in phosphorus export from these areas by as much as 10-fold.

4.1.4 Reducing Agricultural Sources

Between a third and a half of the land draining from the south into Severn Sound is used for crop and livestock production (Figure 4.2). The immediate Severn Sound watershed is drained by six rivers flowing through these agricultural areas. The land draining from the north shore is rocky with little soil cover and is generally covered by forest or wetland (Figure 4.3). The much larger land area draining to the Severn River is also influenced by several large lakes and reservoirs before discharging to Severn Sound at Port Severn.

Figure 4.4 compares the measured phosphorus supply from the streams flowing into Severn Sound including the Severn Sound River and the six monitored watersheds. The total phosphorus load estimated is 19,200 kg/yr. The supply carried ranges from Copeland Creek with a supply of under 200 kg/yr to the Severn River with an average supply of 4,400 kg/yr. The Wye River measurement shows a supply of 3,800 kg/yr. This station is downstream of Elmvale, near Wyevale. Effluent phosphorus supply from the Elmvale lagoon has been subtracted from the calculated supply. However, the supply does include the unmonitored bypass from the Elmvale sewage collection system. Despite the relatively small Wye River watershed area monitored (114 km^2) in comparison with the Severn River (5850 km^2, ie. 2%), the Wye River phosphorus supply is 16% that for the Severn River.

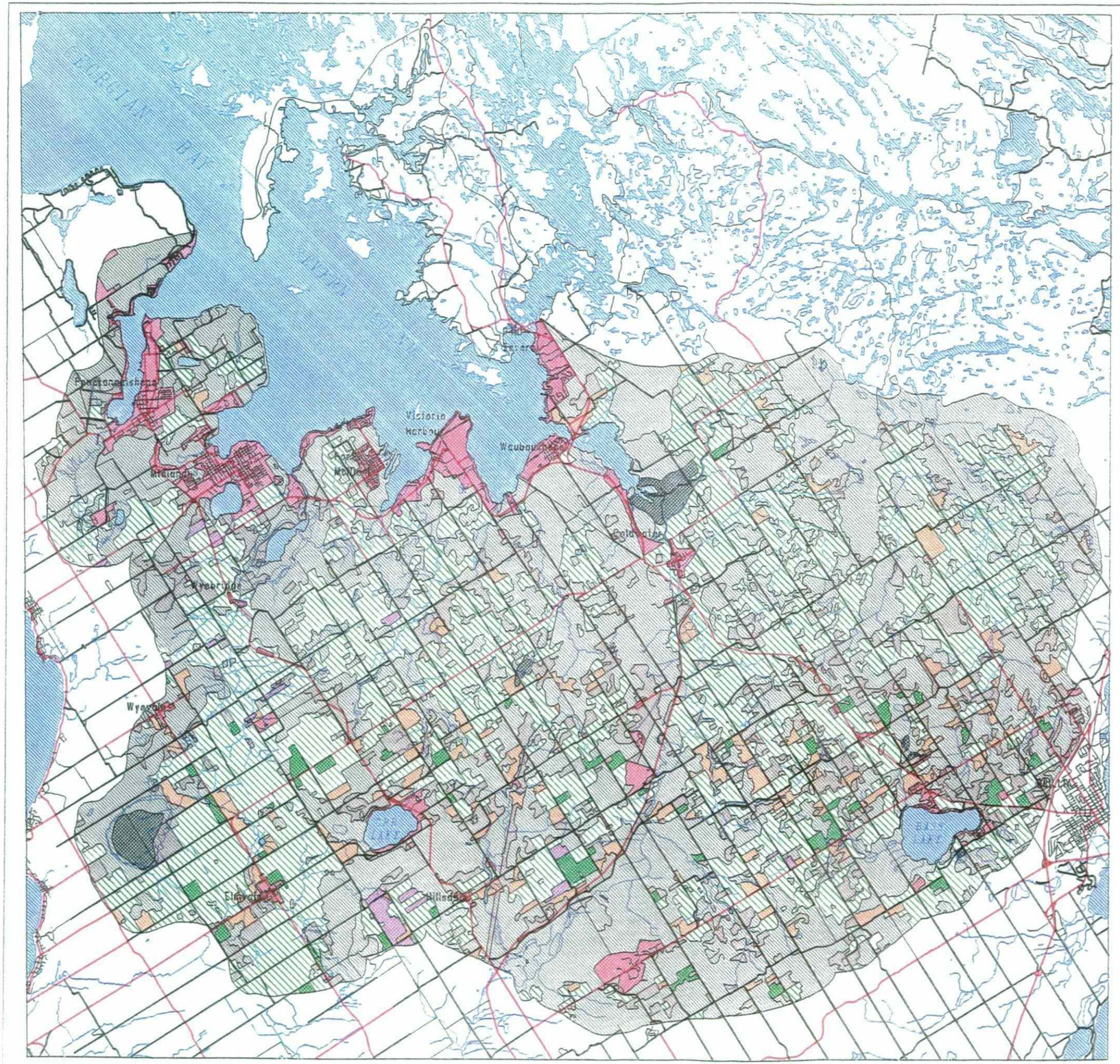
Figure 4.5 compares the phosphorus supply divided by the area monitored or the phosphorus export in the period 1988-1991. The values for most of the watersheds ranged between 10 and 30 kg/km^2. The Severn River was very low (2.3 kg/km^2) as would be expected from a large volume but low concentration inflow. The Wye River phosphorus export was very high (33 kg/km^2). Based on these comparisons, the Wye River watershed is having the greatest proportionate effect on Severn Sound phosphorus supply followed by Hog Creek, Coldwater River, Sturgeon River, Copeland Creek and the North River. The Severn River at Port Severn, although a large supply of phosphorus to Severn Sound, is diluting the waters of Severn Sound with respect to concentration and is therefore having a beneficial effect on the open water quality.

Sources of phosphorus from agricultural activities were evaluated for the Severn Sound watersheds draining from the south. The land use, cropland, soils and slope information was obtained from the Ministry of Agriculture and Food (OMAF, 1983 Inventory; see Figure 4.2). Estimation of phosphorus export from different land uses and slopes was based on Coleman (1982). His values were used for medium to fine textured soils but were modified based on the differences in soil erodibility factors for coarse soil types typical in the Severn Sound watershed.

Figure 4.2

SEVERN SOUND WATERSHED AGRICULTURAL LAND USE SYSTEMS

SCALE 1:165,000



LAND USE SYSTEMS

- INTENSIVE AGRICULTURE (corn, mixed, grain, and hay systems)
- ROW CROPS (corn and beans)
- BUILT UP/URBAN AREAS (includes recreational land)
- ORGANICS (marshes, bogs, swamps)
- SPECIALTY CROPS (extensive field vegetables, market gardens, berries, tobacco, nurseries and sod farms)
- NON-INTENSIVE AGRICULTURE (pasture and grazing systems)
- WOODLOTS (includes reforested and pastured woodlots)
- NON-AGRICULTURAL LANDS (idle lands, extractions pits, dumps)

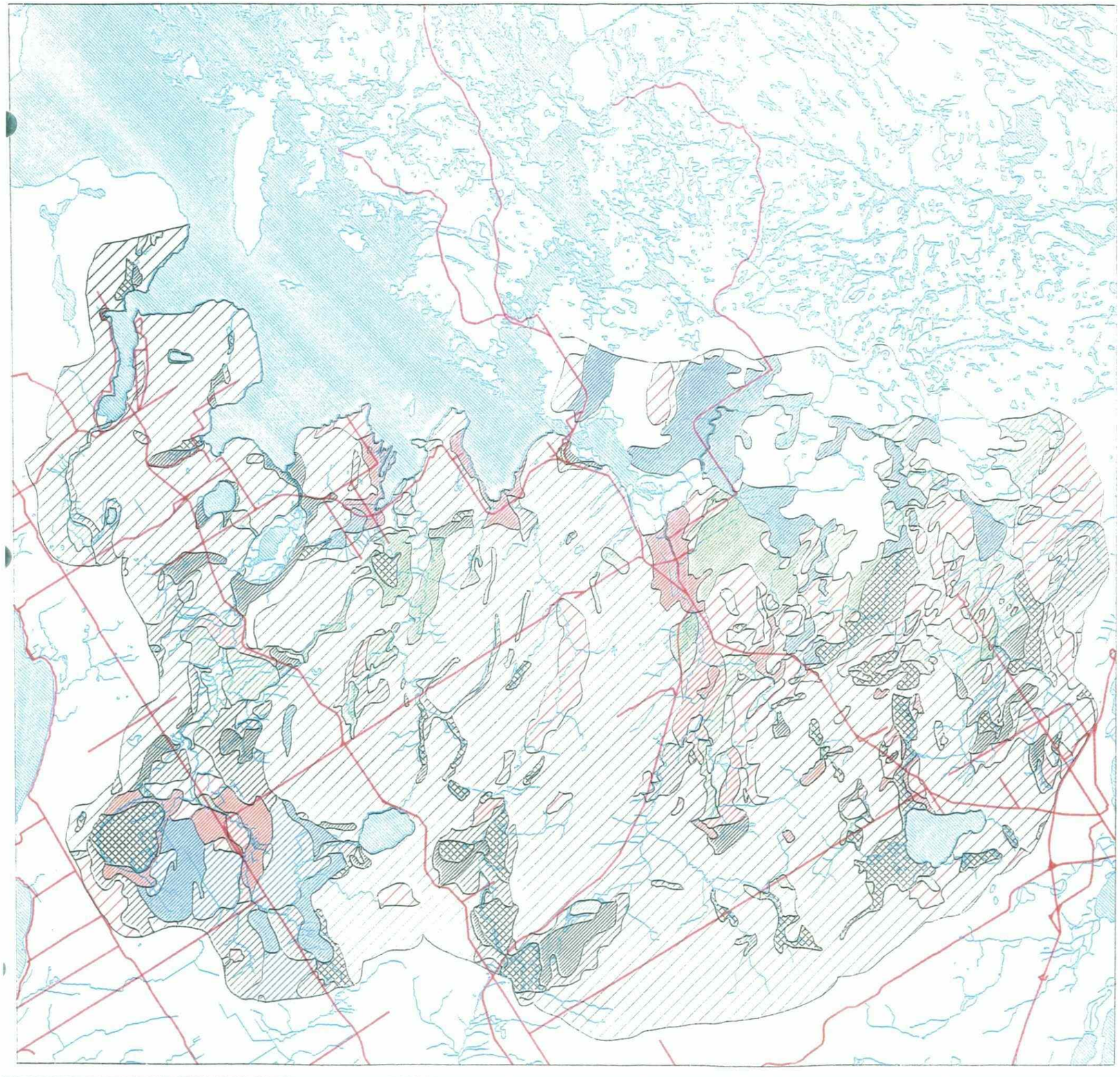
SEVERN SOUND

MAF G.I.S

Figure 4.3:

SEVERN SOUND WATERSHED SOIL GROUPINGS

0 1 2 3 4 5 KM



SURFACE TEXTURE	NATURAL DRAINAGE: WELL	IMPERFECT	POOR
COARSE			
MEDIUM			
FINE			
V. FINE			

ORGANIC SOILS

SEVERN SOUND

MAF G.I.S

Figure 4.4

ESTIMATED ANNUAL PHOSPHORUS LOADS FROM SEVERN SOUND TRIBUTARIES

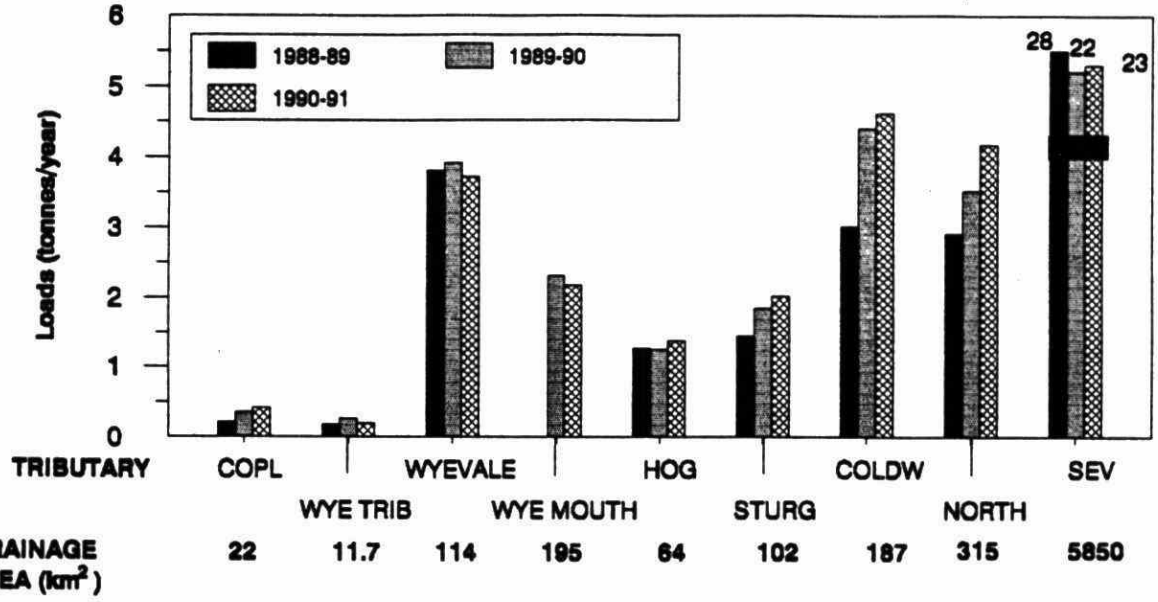
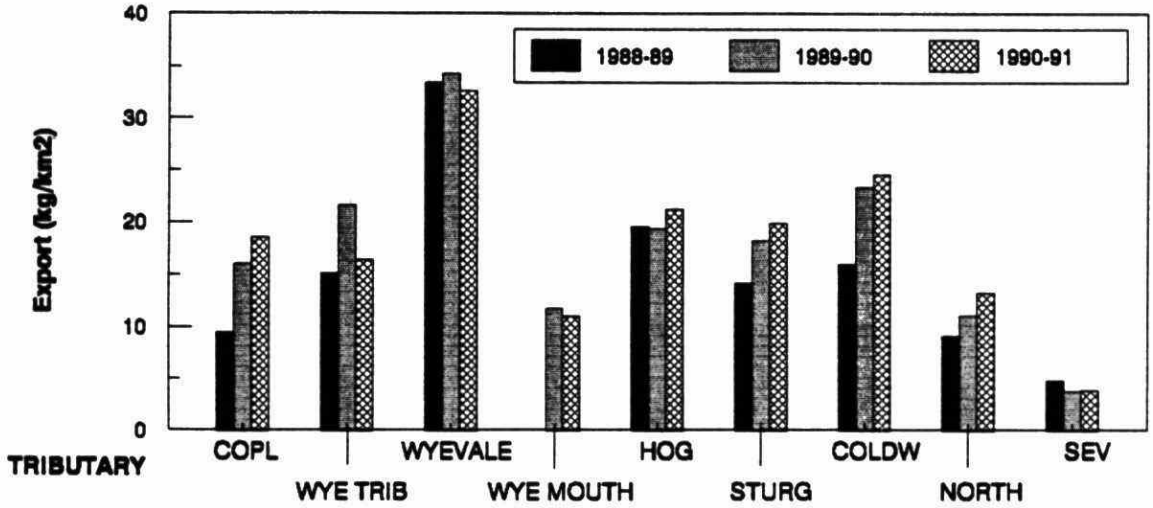


Figure 4.5

ESTIMATED ANNUAL PHOSPHORUS EXPORT FROM SEVERN SOUND TRIBUTARIES



COPL = COPELAND CREEK
WYE TRIB = WYE TRIBUTARY AT ELMVALE
WYEVALE = WYE RIVER AT WYEVALE
WYE MOUTH = WYE RIVER AT HWY 12
HOG = HOG CREEK
STURG = STURGEON RIVER
COLDW = COLDWATER RIVER
NORTH = NORTH RIVER
SEV = SEVERN RIVER

Farm Sources

Figure 4.6 shows areas of high, medium and low soil loss potential within the Severn Sound watershed. Areas where cropland was located on zones of high soil loss potential were examined in more detail in order to advise these farmers to consider alternate practices. Areas of high soil loss potential were found in each watershed. Extensive areas of high soil loss potential were found on or near the Wye River and Hog Creek with smaller areas present in the Sturgeon, Coldwater and North Rivers.

A livestock survey was conducted by the RAP Team in 1990-91 of each farm in the Severn Sound area to determine livestock numbers, cattle access, manure handling practices and milkhouse waste handling in relation to water courses.

Farm sources of phosphorus, as indicated by the survey, were most concentrated in the Wye and Hog watersheds (Table 4.3). The highest density of animal units was found in Hog Creek and the Wye River watersheds. The greatest number of potential sites for remediation, on a drainage area basis, were found in the Wye River and Hog Creek. However, the largest number of livestock access locations was found in the North River even though the number of animal units was lower than the Wye River.

The effectiveness of the possible remedial measures to reduce phosphorus from agricultural sources was reviewed by the RAP Team (Table 4.4).

Spreading of Sewage Sludge and Septage

Municipalities operating communal sewage plants generally collect sewage within municipal boundaries. Those municipalities without sewage plants generate phosphorus sources from septic tank and holding tank waste in addition to seepage through the tile field to the receiving waters. These "open loops " of waste generation and disposal represent a controllable source of phosphorus and require further action.Spreading of sewage plant sludge presently occurs on a year round basis in Severn Sound. Once spread, sludge is not normally cultivated into the soil. With proper care in monitoring sludge quality and application, sludge provides an environmentally acceptable soil conditioner which adds to the nutrient and organic content of the soil. Spreading of sewage sludge is controlled by the MOEE under the Sludge Utilization Guidelines. Fields are screened prior to acceptance for slope, soil conditions and setback distances to watercourses. Only sludge meeting the quality requirements under the Guidelines (OMAF/MOE, 1992) is permitted to be spread on farmland. The quality of sludge for all of the mechanical plants with the exception of Midland is acceptable for spreading on farmland. Midland WPCP has improved sludge quality over the last 10 years due primarily to reductions in input to the sewers from metal plating industries in Town. Improved sludge quality has permitted the spreading of Midland sludge at 25% of the normal rate following addition of nitrogen.

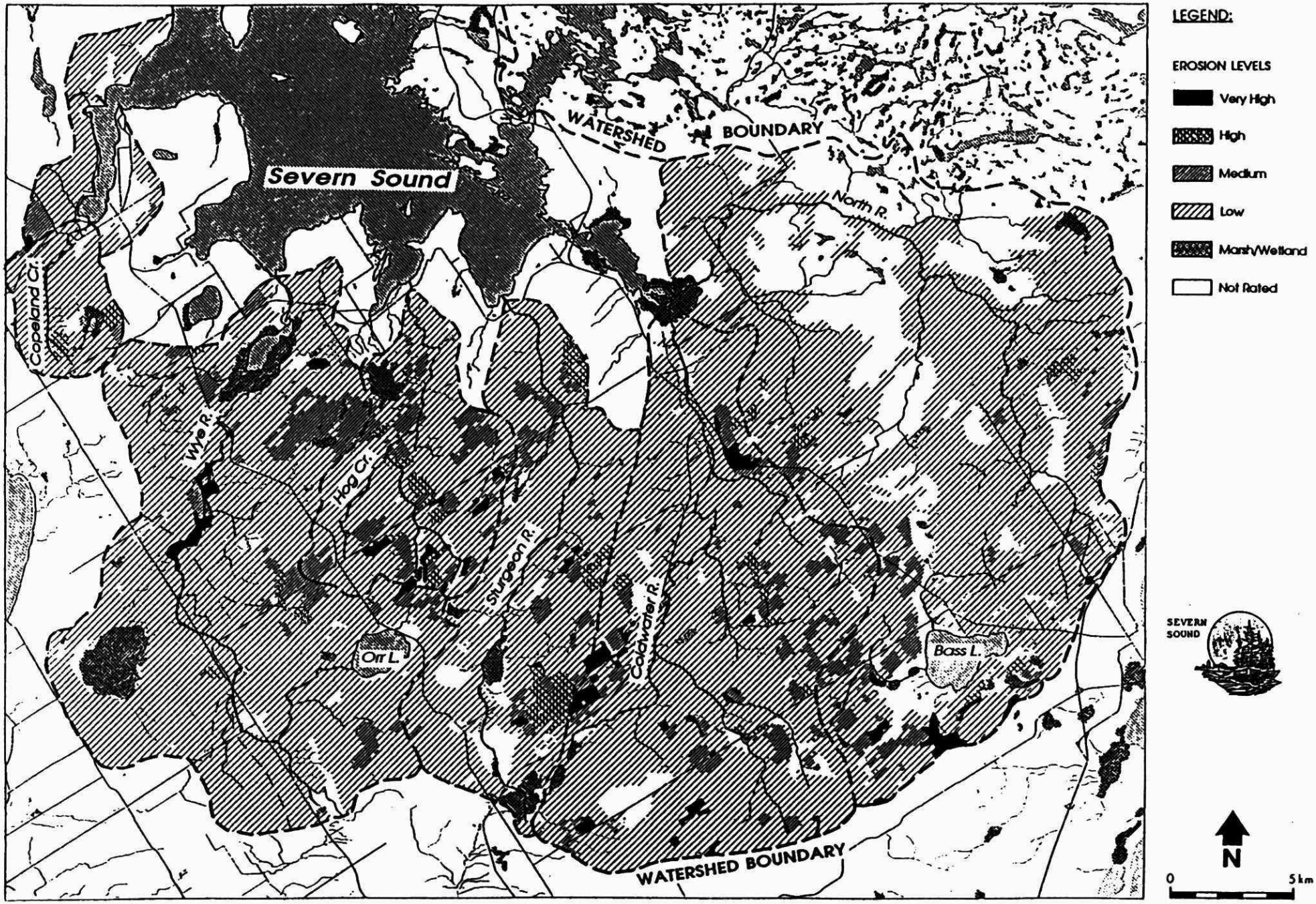


Figure 4.6: Severn Sound Watershed Soil Erosion Potential

Table 4.3
Summary of Potential Sites for Remediation of Farm Sources in Severn Sound Watersheds.

	Copeland	Wye	Hog	Sturgeon	Coldwater	North	Total
Area (Km^2)	22	216	64	102	188	315	907
Livestock Operations (>10 animal units)	7	116	43	32	62	115	375
Total Animal Units	230	3712	1296	1036	1954	3385	11613
Density (Units/Km^2)	10	17	20	10	10	11	78
Cattle with access to stream (sites/units)	1 80	13 441	11 717	4 438	9 955	52 1250	90 3881
Milkhouse Washwater	0	18	6	4	5	9	42
Manure Storage # Solid Stacks (within 200m)	4	35	19	7	16	33	114
Septic Systems (within 200m)	4	37	21	7	22	54	145

Source: as of 1991, Farm Sources Survey for RAP Team (1991) by B. Agar.

TABLE 4.4: THE EFFECTIVENESS OF RECOMMENDED ACTIONS TO REDUCE PHOSPHORUS FROM AGRICULTURAL SOURCES

Source	Suggested Action	Expected Result
1) Soil Erosion from farmland	i) Retire highly erodible fields from cultivation through planting of trees or perennial forages or use of no-till planting systems	70% reduction.
	ii) Usage of reduced tillage or no-till systems for growing grain and oilseed crops	Up to 70% reduction in total phosphorus.
	iii) Use of erosion control structures in ditches and waterways	Unknown.
2) Milkhouse Wash Water	Eliminate direct discharges of wash water into drains or watercourses	Reduce phosphorus by 40Kg/yr for a typical milkhouse.
3) Livestock Manure	i) Prevent runoff into watercourses or drains of contaminated water from manure storages or barnyards	Improve local conditions for phosphorus and other contaminants.
	ii) Incorporate manure into the soil within 24 hours of spreading	Highest potential benefit of nutrient and soil conditioning value.
	iii) Eliminate the spreading of manure during winter (e.g. Nov 30 to Apr 15)	Reduce loss of phosphorus during high runoff periods.
4) Livestock Access to Streams	i) Fence off pasture land	100% reduction in direct pollution of a stream from animals (decrease bank erosion and allow vegetation to stabilize banks of streams).
	ii) Provide restricted crossings for livestock	see above (1(i) and 1(iii))
	iii) Usually linked with bank valley lands and stream rehabilitation (see above)	see above (1(i) and 1(iii))
5) Rural Sewage Systems	Upgrade seriously substandard or faulty septic tanks and tile fields	80% reduction where system is faulty

Table 4.5 shows the volume of sludge spread in Severn Sound Watersheds during 1990 and 1991. Virtually all sludge spread in Severn Sound originated from Severn Sound sewage plants. The largest areas and amounts of sludge are spread in the Wye and Coldwater Watersheds.

The existing WPCPs have little or no sludge holding capacity. Improved treatment is expected to exacerbate this problem in that more sludge will be generated. There is a high potential for erosion of sludge spread on fields in winter and early spring. Frozen land or land that is saturated during spring (typically between November 30 and April 15) allows much less retention of sludge applied than during other times of the year. To reduce the high potential for addition of phosphorus to the spring runoff it is recommended that spreading not be carried out during winter and early spring and that spreading be followed immediately by incorporation of the sludge into the soil where possible to maximize the benefit. In order for this recommendation to be carried out the available sludge holding capacity in the area sewage plants must be expanded. Municipalities operating mechanical plants are considering a communal sludge holding facility for the Severn Sound area to achieve storage and better management of sludge over winter.

Septic tank and holding tank waste generated in private sewage systems can be spread on land or treated at sewage treatment plants under the existing MOEE Guidelines. In general, hauling and spreading does not occur in winter. The Simcoe County Health Unit is trying to phase out the practice of spreading septage on land. However, most sewage plants are not equipped with holding facilities for the routine treatment of septage. Septic tank and holding tank waste volumes spread in Severn Sound watersheds are about less than 7% of sludge volumes (Table 4.6). Again, prior to the recommended action of eliminating the spreading of septage on land, adequate handling facilities and procedures should be developed by those municipalities operating sewage treatment plants.

Potential phosphorus reductions from watersheds

A comparison was made between the estimated reductions in phosphorus loads for each watershed source discussed above and the measured phosphorus load leaving the watershed. With the assistance of the OMAF Geographic Information System (GIS) unit, the land use and farm survey information was used to target potential sites for remediation of farm sources in relation to Severn Sound watercourses. In addition, the relative magnitude of phosphorus supply from various watershed sources was calculated for each watershed (Figure 4.7). Assumptions for calculations are found in Appendix 4.1.

Figure 4.8 summarizes the potential phosphorus reductions that could be realized from implementing the recommended actions in Severn Sound watersheds. A major direct reduction in phosphorus supply to the Wye River from the Elmvale sewage plant is expected following replacement and upgrading of the main sewage pumping station (1992) and expansion and upgrading of the sewage treatment plant (approval in progress).

TABLE 4.5: SEWAGE SLUDGE APPLICATION TO LAND IN THE SEVERN SOUND WATERSHED.

WATERSHED	# OF SITES	AREA (HA)	QUANTITY APPLIED (M^3) 1990	QUANTITY APPLIED (M^3) 1991
Penetanguishene (Copeland Creek)	2	6.9	283.2	2462.7
Midland (Wye River)	6	123.9	0	4395.3
Hog Creek	1	15.3	436.8	376.2
Sturgeon River	0	0	0	0
Coldwater River	3	53.2	546	1310
North River	1	64.8	1446.9	1255.8

Source: MOE Barrie District, 1990, 1991 data.

TABLE 4.6: SEPTIC AND HOLDING WASTE APPLICATION TO LAND IN THE SEVERN SOUND WATERSHEDS.

WATERSHED	# OF SITES	AREA (HA)	SEPTIC (M^3)	HOLDING (M^3)
Copeland	3	11.0	4115	993
Wye	3	19.2	1711	2035
Hog	0	0	0	0
Sturgeon	3	7.1	1468	1775
Coldwater	0	0	0	0
North	1	3.1	170	36

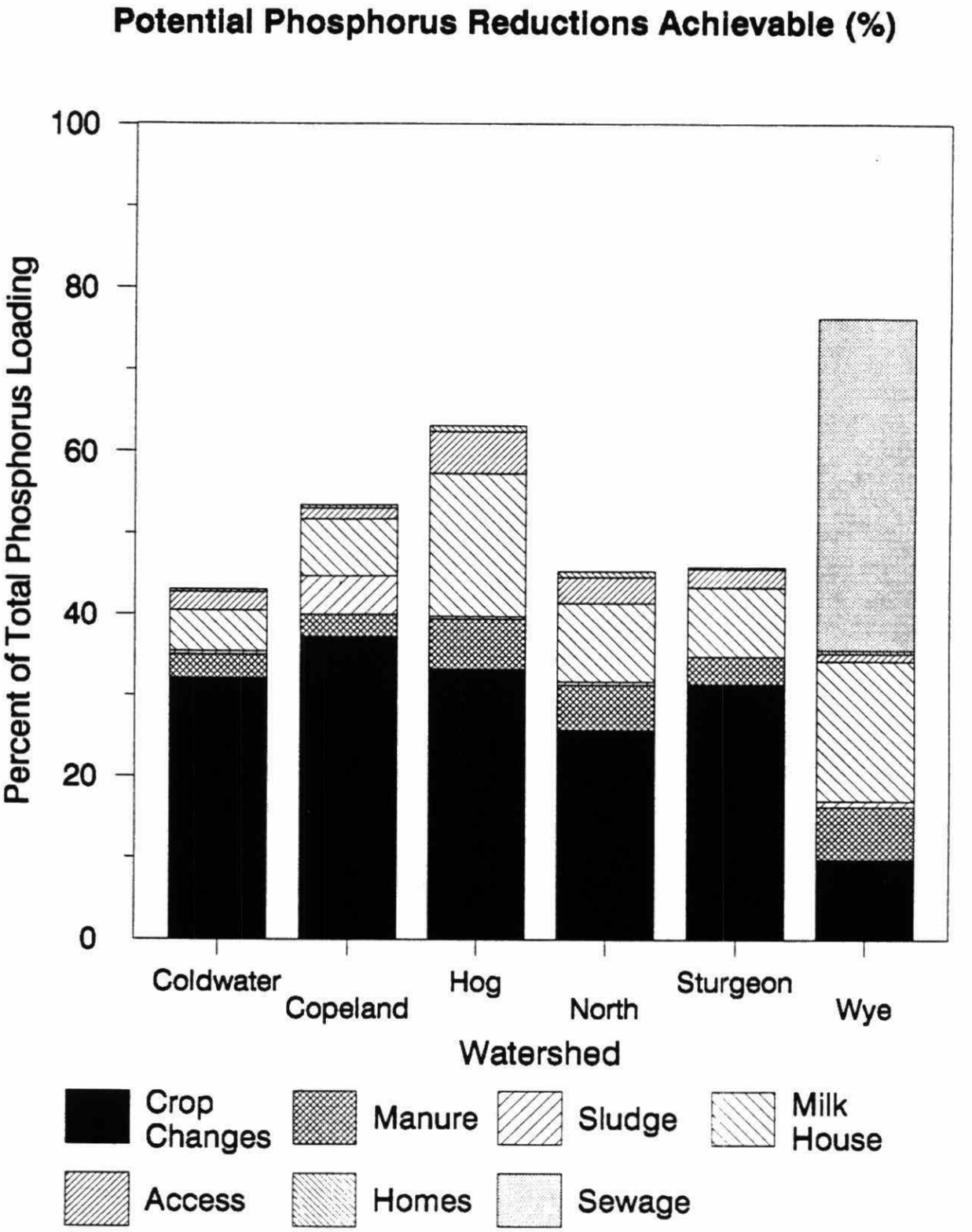
Source: Simcoe County Health Unit, 1991 data.

The greatest potential reduction in phosphorus supply from watersheds can be made by changing cropping practices on highly erodible fields to reduce soil erosion and export of total phosphorus. If the highly erodible land (>9% slope) that is presently in row crops and mixed grain was retired from cultivation or changed to less erodible crops such as hay, a potential reduction of 25 to 38% in the phosphorus supply from those fields will result. The actual benefit to the supply from each watershed to Severn Sound will depend on the delivery of phosphorus.

Apart from erosion, phosphorus supply from other sources that directly impact stream quality and downstream Severn Sound can be reduced. Three major farm sources of phosphorus are milk house waste, manure management and livestock access. Figure 4.7 indicates that the greatest reduction in these sources can be achieved in the Wye River, the North River and Hog Creek where the highest number of livestock operations are found. The reduction in phosphorus from eliminating winter spreading of sludge and septage is relatively very small with the most significant effect on Copeland Creek and the Wye River watersheds.

The calculations of potential reductions are based on a number of assumptions concerning the delivery of phosphorus from fields and sources to streams and then to the downstream waters of Severn Sound. For this reason the values in Figure 4.7 should be used for relative evaluation of watershed sources. Taking these cautions into consideration, a RAP objective of 20% reduction in watershed sources in absolute terms (kg P/yr) appears reasonable. Applying the 20% reduction to the measured load (Figure 4.4), a total of 2,950 kg/yr in phosphorus reduction can be expected if the recommended actions are followed on a substantial number of the potential remediation sites in each watershed.

Figure 4.7


Potential Phosphorus Reductions Achievable (%)
Percent of Total Phosphorus Loading
100
80
60
40
20
0
Coldwater
Copeland
Hog
North
Sturgeon
Wye
Watershed
Crop Changes
Manure
Sludge
Milk House
Access
Homes
Sewage

4.1.5 Reducing Phosphorus from Marine Activities

Severn Sound and area is extensively used for pleasure boating. There are 33 marinas and five federal small craft facilities within Severn Sound with an excess of 6,000 boat slips. The Sound serves as a starting point for trips into other areas of Georgian Bay and as the western entrance to the Trent-Severn waterway. Some 10,500 vessels pass up or down the lock at Port Severn each year. Many of these boats are larger vessels that have on-board plumbing.

Under MOEE Regulations, all toilet waste must be retained in a holding tank that can only be pumped out at a sewage pumpout station on shore. As part of the Shoreline Pollution Survey, on-board sewage holding facilities were inspected. The great majority of boats inspected (280 of 300 inspected) were in compliance with the regulations. Those few owners not in compliance either had no holding tank or had the ability to discharge the holding tank while on the open water through the use of a 'Y' valve. In localized areas such as sheltered bays, this practice could seriously pollute the water with sewage related nutrients such as phosphorus and disease causing bacteria. However, it is expected that in Severn Sound, which has adequate pumpout station capacity, this type of discharge would be very rare and would not contribute significantly to the open water phosphorus concentrations.

Retention of grey water or wash water from galley sinks and showers on board pleasure craft is not presently required. Changes in the regulations forthcoming will require "live-a-board" boats, rental boats and new boats constructed after 1995 to retain grey water. Studies of the quality of grey water (Beak, 1989) measured phosphorus concentrations typical of raw sewage, elevated indicator bacteria and the presence of known pathogenic bacteria in on-board grey water. Using a conservative assumption of boat usage, residence in Severn Sound and grey water quality, phosphorus load contributed to various general areas of Severn Sound.

Another effect of boating on the eutrophication problems in Severn Sound is the release of additional nutrients and the destruction of habitat during marine construction (addressed in section 4.2).

The indirect effects of marine construction on water quality results from the disturbance of phosphorus in sediments and the shoreline when dredging or shoreline alteration occurs. The amount contributed depends on the size of the projects and the methods used in construction. Similar concerns for the addition of silt and the destruction of nearshore habitat from marine construction have been noted for the protection of fish and wildlife habitat. The same actions that deal with mitigation of the effects of marine construction projects on habitat also generally reduce the effects on water quality provided that dredge spoils are properly disposed of (see section 4.2).

4.1.5 Effect of Phosphorus Control Actions on Severn Sound Quality

The potential reductions in phosphorus supply from the various controllable sources have been reviewed in detail above. The effect of these reductions on the water quality of Severn Sound was evaluated using the empirical model of Dillon (Dillon and Rigler, 1974; Dillon et al., 1986). Wherever possible, local measurements were used to tailor the model for use in Severn Sound. Calculations were carried out on the four areas described in Figure 4.8 with basic assumptions as described in Appendix 4.2.

Principles

To consider the effect of phosphorus control actions on Severn Sound, several principles have been applied.

The importance of concentration

Total phosphorus concentration is a major factor controlling the growth of algae in the open waters of Severn Sound. High concentration - low volume discharges such as sewage plant effluents are more biologically available and stimulate algae growth more than low concentration - high volume discharges such as large rivers. Nicholls and Heintsch (1992) have shown that "caged" algae growth was consistently stimulated near sewage plant discharges while growth was not stimulated at the mouth of the Severn River.

Caps on Sources

There is a finite cap of phosphorus supply from controllable and uncontrollable sources which must not be exceeded in order to maintain the appropriate total phosphorus concentration in the open waters.

Pollution Prevention

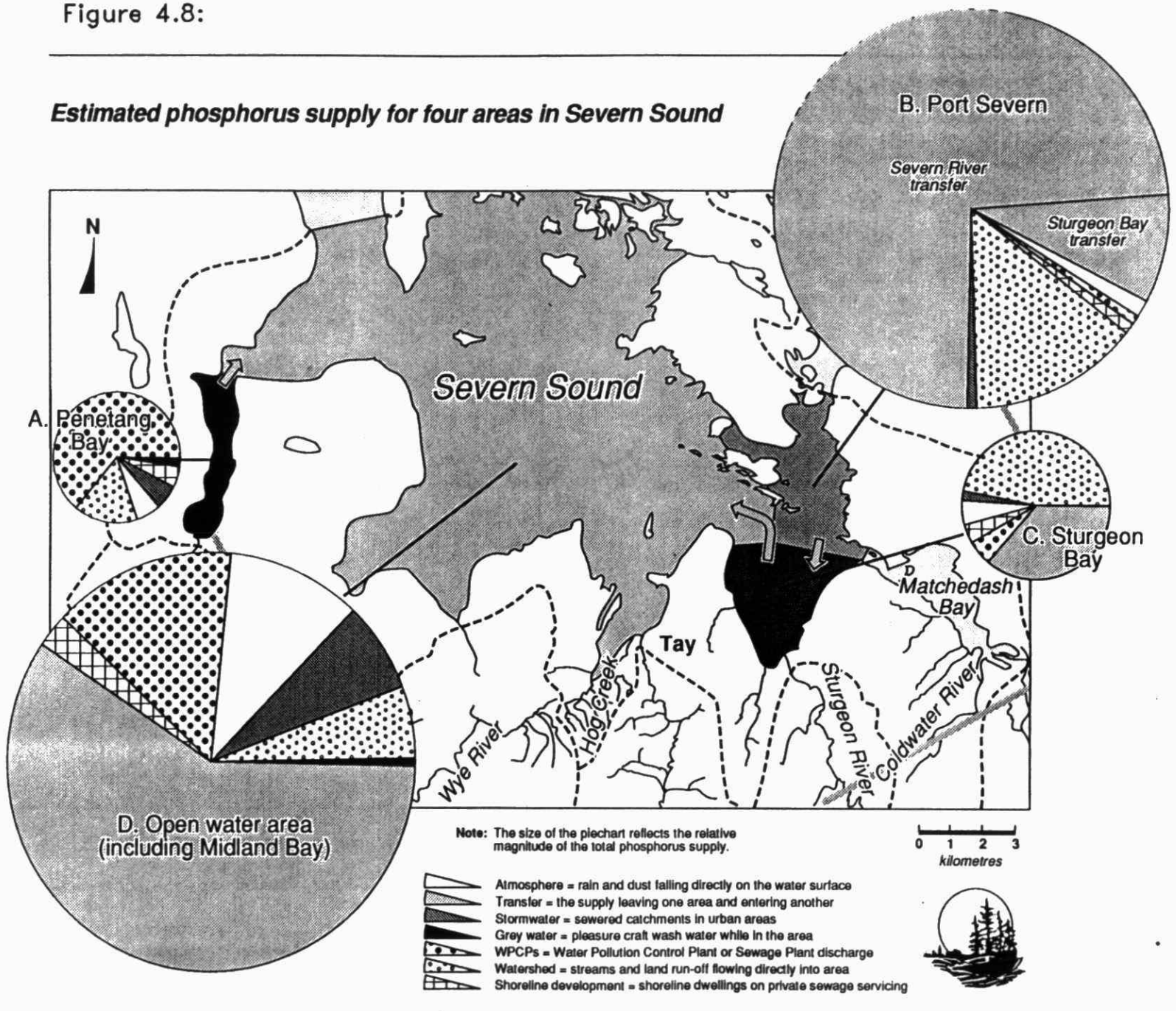
The effect of discharges on Severn Sound quality must be considered as close to the source as possible. For example, a sewage plant discharge must be considered from the households and industries discharging to the plant, to the immediate downstream quality, and then to the effect on the open waters of Severn Sound and even to the effect on Georgian Bay.

Growth must be taken into account

Expansion of most existing sewage plants and the construction of new plants is presently under review by municipalities. Growth must be planned on the basis of reducing the resulting load following expansion to **less than the existing loading** in order to accommodate the growth and to improve water quality of Severn Sound.

Figure 4.8:

Estimated phosphorus supply for four areas in Severn Sound


B. Port Severn
Severn River transfer
Sturgeon Bay transfer
N
Severn Sound
A. Penetang Bay
C. Sturgeon Bay
Matchedash Bay
Tay
Hog Creek
Wye River
Sturgeon River
Coldwater River
D. Open water area (including Midland Bay)
Note: The size of the piechart reflects the relative magnitude of the total phosphorus supply.
0 1 2 3
kilometres
Atmosphere = rain and dust falling directly on the water surface
Transfer = the supply leaving one area and entering another
Stormwater = sewered catchments in urban areas
Grey water = pleasure craft wash water while in the area
WPCPs = Water Pollution Control Plant or Sewage Plant discharge
Watershed = streams and land run-off flowing directly into area
Shoreline development = shoreline dwellings on private sewage servicing

Upstream to downstream

The immediate receiving water quality should be considered for restoration, as well as the open Sound. For example, a sewage plant discharge to a stream that flows into Severn Sound should be assessed based on the impact and on the immediate downstream quality and then on the impact on the Sound.

Biologically "available" phosphorus relatively more important for algae growth

Algae can use some forms of phosphorus better than other forms for growth. The preceding review of phosphorus sources was based on the total phosphorus (i.e. a test that includes all forms of phosphorus). Phosphorus sources of human origin (sewage plants, seepage from private sewage systems, grey water) and some aspects of storm water and land drainage have an higher proportion of biologically available phosphorus (the form that algae can use best). The relative influence of these sources on algae growth are much greater and increase the importance of controlling these sources.

Phosphorus strategy options and expected quality changes

Five scenarios were considered in order to evaluate the overall effect of recommended phosphorus control measures (see Figures 4.9.1-4)

1. The existing conditions were used to predict existing measured quality. This is a check on the accuracy of the model to predict conditions in the four areas of the Sound.
2. Existing treatment of various sources with expected growth in sources due to population growth or other changes. This is the "do nothing more" option. The same growth forecast is assumed in each subsequent option.

3a. Improved phosphorus removal from sewage plant effluents according to the interim strategy for sewage plants (see Table 4.1) is evaluated with no change in other sources.

3b. Improved sewage plant effluent and reduction in the phosphorus supply from rural and urban land.

4. Phosphorus removal is improved at sewage plants to achieve the very low effluent phosphorus concentrations of <0.10 mg/L.
5. This option evaluates the effect of consolidating all existing sewage plant effluents with improved treatment (Option 3b above) and discharging them to the open Sound.

Comparison of predicted Total phosphorus concentration [TP] with measured [TP]

Predicted [TP] compared reasonably well with measured [TP] (Table 4.7). The greatest divergence between predicted and measured [TP] was noted in the open portion of the Sound, depending on whether the estimated exchange with Georgian Bay was assumed to apply to the entire open Sound or not. The predicted [TP] for Sturgeon Bay is lower than measured [TP] (15 ug/L predicted, 19 ug/L measured).

Open Severn Sound (see Figure 4.9.1)

The target open water [TP] for the Open Sound is 15 ug/L or less. This corresponds to a total phosphorus supply from all sources of 47.5 metric tons. This is based on a conservative approach that assumes that the exchange occurring with Georgian Bay waters does not influence the entire open Sound.

The effect of doing nothing more to control phosphorus and assuming growth will result in an increase in the total supply to over 60 metric tons per year. This will result in an increase in [TP] to >19 ug/L and increased algae density. The accompanying effects will be a greater incidence of nuisance algae conditions and worsening of the low oxygen concentrations in the bottom waters.

Upgrading phosphorus removal efficiency of sewage plants discharging directly to the open Sound to provide effluent [TP] of 0.3 mg/L or less (Option 3a) will reduce the open water supply and [TP] below existing conditions even with the incorporation of forecast growth. Combining the improved treatment with reduced supply from urban storm water and watershed sources (Option 3b) will reduce the supply and [TP] further, achieving the target open water phosphorus concentration of <15ug/L.

The additional reduction in phosphorus supply gained by upgrading all sewage plants to reduce phosphorus in the effluent from 0.30 to 0.10 mg/L or less will not be sufficient to make a measurable change in the open water quality. The very high cost of achieving this additional reduction would then not be warranted for the open Sound.

The consolidation option (option 5) will also make no measurable change in conditions. Most of the supply from sewage plant effluents already discharges to the open Sound with the exception of the Town of Penetanguishene plants, the Village of Elmvale plant and Village of Coldwater plant. With the upgrades proposed for these plants, the discharge of these improved effluents will have no measurable effect on the open Severn Sound.

Improvements in phosphorus removal at the Elmvale sewage plant (discharging to the Wye River) and reduction in watershed sources are necessary in order to meet downstream [TP] of 0.030 mg/L in the Wye River. According to calculations in the Village of Elmvale Environmental Study Report (Ainley and Associates, 1992) the effluent [TP] must be <0.15 mg/L in order to meet downstream quality under low flow conditions.

Table 4.7: Comparison of predicted and measured total phosphorus concentration [TP] in the four areas of Severn Sound under existing conditions (results are mean total phosphorus concentration for the ice free period in ug/L)

AREA OF SEVERN SOUND	PREDICTED [TP]	MEASURED [TP]
Open Severn Sound	17*	17
Penetanguishene Bay	38	37
Port Severn area	16	13**
Sturgeon Bay	15	19

* assuming exchange with Georgian Bay does not influence the entire open Sound.

** Severn River [TP] at Port Severn

Predictions are made using model of Dillon et al. (1986) with modifications (assumptions in Appendix 4._).

Figure 4.9.1

SEVERN SOUND PHOSPHORUS SUPPLY
FROM ALL SOURCES ENTERING THE OPEN SOUND

(see legend below)

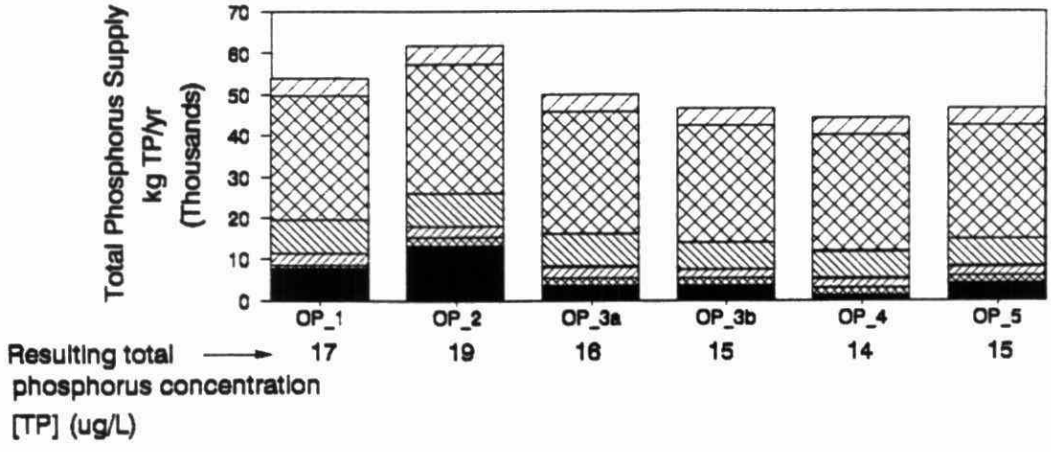
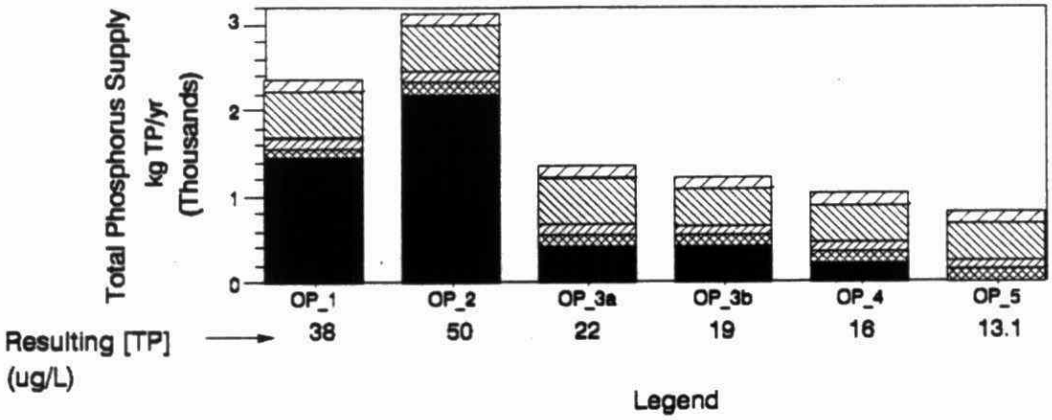


Figure 4.9.2

SEVERN SOUND PHOSPHORUS SUPPLY
FROM ALL SOURCES ENTERING PENETANG BAY

(see legend below)



Legend

SEWAGE PLANTS	
SHORE	
STORM	
WATERSHED	
TRANSFER	
ATMOSPHERE	

Option	
OP_1	Existing
OP_2	With pop'n growth, no new treatment
OP_3a b	Interim effluent improvements and reduced rural and urban supply
OP_4	Improve sewage plant effluents to <0.10 mg/L
OP_5	Consolidate discharges to open sound

Penetanguishene Bay (Figure 4.9.2)

In order to meet the target [TP] of <20 ug/L in the south end of Penetanguishene Bay, a total supply of 1000 kg P/yr or less must be achieved. The Interim Phosphorus Control Strategy (Severn Sound RAP, 1990) for Penetanguishene Bay also recommends a cap of 270 kg/y from both sewage plants discharging to the Bay.

The "do-nothing-further" option (Option 2) will result in a significant degradation in the quality of the Bay and is not considered further. Improving phosphorus removal at the Sewage Plants to an effluent [TP] of 0.15 mg/L will result in a substantial reduction over the existing supply. However, the target concentration and load will not be met. The additional reduction in watershed sources and urban storm water will reduce the total load to just above 1000 kg/yr and thus achieve the open water [TP] target for the Bay. Option 4 will measurably reduce the total load further and will just meet the target load and [TP]. The consolidation option which would remove the discharges from the Bay will further reduce the total supply and achieve the targets. Unless the technology for phosphorus removal can be improved beyond what is currently feasible, the Town will have to consider other options including consolidation of discharges to a location outside of the Bay in any expansions beyond the forecasted sewage flows.

In this case the option of improving treatment to achieve a very high degree of phosphorus removal has been accepted by the Town of Penetanguishene and has been pursued in the Main St. WPCP and in the Fox St. WPCP upgrade. These improvements await funding.

Port Severn area (Figure 4.9.3)

The phosphorus supply for this area is driven by the overwhelming effect of the Severn River inflow. The current status of the Severn River quality at an average [TP] of 13 ug/L suggests that only the concentration target of </= 15 ug/L has already been met. The retention of phosphorus in this area is estimated at only 5% of what leaves the area for the open Sound due to the high flushing rate. A small reduction in the total supply is achieved over existing conditions with the combination of improvements in phosphorus removal at Coldwater WPCP and in reductions in watershed sources (Option 3b). No further measurable improvement is expected by pursuing further sewage plant reductions or consolidation (Option 4 and 5).

Within the immediate watershed draining to the Port Severn area, improvement in phosphorus removal at the Coldwater WPCP will improve the downstream quality of the Coldwater River and the area of Matchadash Bay associated with the River mouth.

Sturgeon Bay (Figure 4.9.4)

Sturgeon Bay is a shallow bay with dense beds of rooted aquatic plants. The presence of the plant beds has the effect of competing with the suspended algae for nutrients and light.

This competition also interferes with the functioning of the model used to predict effects of remedial actions so that caution should be exercised when interpreting the absolute loads and open water concentrations predicted. The relative changes, however, suggest that reductions in watershed sources (Option 3b) have the greatest influence on the total supply to Sturgeon Bay. Victoria Harbour WPCP already provides a high degree of phosphorus removal and little is gained by pursuing further reduction, especially in view of the significant decrease in open water phosphorus concentration following start up of the WPCP. Further improvements would likely result in the quality of Sturgeon through connection of shoreline private systems (especially in low lying areas in the south end of the Bay) to the collection system of the Victoria Harbour WPCP. The Bay is presently meeting the target open water [TP].

It must be noted that significant decline or removal of the rooted aquatic plants could result in deterioration of the water quality of the Bay. The rooted plants "tie up" phosphorus that would otherwise be used by suspended algae.

North Shore

The north shore area includes numerous bays and islands including Beausoleil Bay, North Bay, South Bay and the Honey Harbour area. North Bay and South Bay have been treated as tributaries to the Sound in nutrient budget calculations carried out by MOE Central Region and the District of Muskoka (Appendix 4.3). These two bays are considered sensitive to the effects of further shoreline development. Other areas that are nearly separate basins have many channels connecting them to the rest of the Sound. Complicated patterns in and out of these channels does not allow the simple nutrient calculations used in this assessment. The Honey Harbour area including Royal Island has some 9 channels connecting the main embayment to other parts of the North Shore. The area is very rocky and is considered more sensitive to phosphorus input from development than the open Sound would be.

Strategy

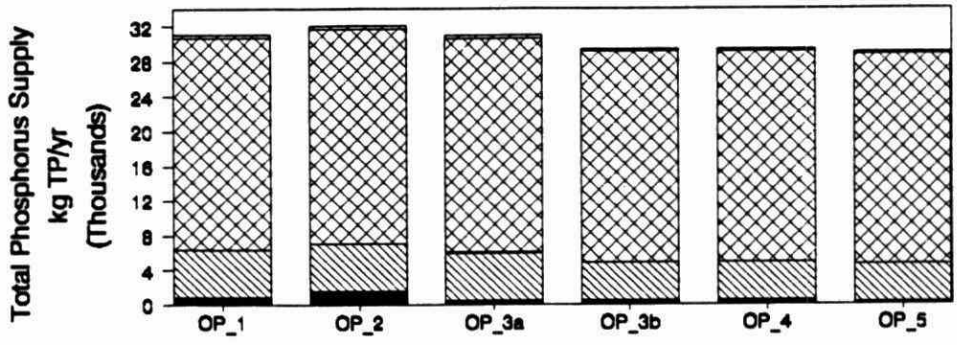
Table 4.8 summarizes the strategy for controlling phosphorus in the four main areas of Severn Sound. The loading targets for sewage plants incorporate some margin for fluctuations in effluent quality and are meant to provide a guide for specific loading requirements for each individual plant. The individual requirements should be developed for each plant as the design flow and treatment become available during the project approval process.

The resulting quality of the open waters should meet the desired quality as outlined in section 3.3.

Figure 4.9.3

SEVERN SOUND PHOSPHORUS SUPPLY
FROM ALL SOURCES ENTERING THE PORT SEVERN AREA

(see legend below)

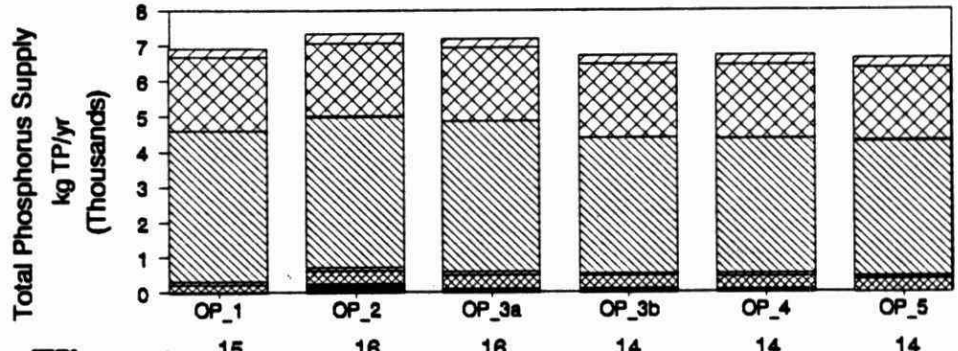


	OP_1	OP_2	OP_3a	OP_3b	OP_4	OP_5
Resulting total phosphorus concentration [TP] (ug/L) →	16	16	15	15	15	15

Figure 4.9.4

SEVERN SOUND PHOSPHORUS SUPPLY
FROM ALL SOURCES ENTERING STURGEON BAY

(see legend below)



	OP_1	OP_2	OP_3a	OP_3b	OP_4	OP_5
Resulting [TP] (ug/L) →	15	16	16	14	14	14

Legend

SEWAGE PLANTS	
SHORE	
STORM	
WATERSHED	
TRANSFER	
ATMOSPHERE	

Option	
OP_1	Existing
OP_2	With pop'n growth, no new treatment
OP_3a b	Interim effluent improvements and reduced rural and urban supply
OP_4	Improve sewage plant effluents to <0.10 mg/L
OP_5	Consolidate discharges to open sound

TABLE 4.8

PHOSPHORUS CONTROL STRATEGY FOR SEVERN SOUND

	PENETANG BAY		STURGEON BAY		PORT SEVERN		OPEN SEVERN SOUND	
SOURCE	Conc. (mg/L)	Load (kg/yr)	Conc. (mg/L)	Load (kg/yr)	Conc. (mg/L)	Load (kg/yr)	Conc. (mg/L)	Load (kg/yr)
WPCP Effluents*	<0.10	270	<0.15	259	<0.3		<0.3	
Bypassing / CSO		Virtually Eliminated		Virtually Eliminated		Virtually Eliminated		Virtually Eliminated
Storm Water+		decrease by 20%*		decrease by 20%*		decrease by 20%*		decrease by 20%*
Watershed+	<0.3	decrease by 20%*	<0.03	decrease by 20%*	<0.03	decrease by 20%*	<0.03	decrease by 20%*
Shoreline	Replace faulty or substandard systems (20% of systems), establish phosphorus removal efficiency target.							
EXPECTED OPEN WATER QUALITY								
[TP] (ug/L)	<20	1000 Kg/yr	<15	6800 Kg/yr	<15		<15	47500 Kg/yr
[Chl. a] (ug/L)	<7		<5		<5		<5	
SDV (m)	>2		to bottom		>3		>3	
Aquatic Plant‡	increase 30%		no change		no change		no change	
Min. D.O. (mg/L)	>5		>5		>5		>5	

* Sewage plants include: Main St. WPCP and Fox St. WPCP (Penetang Bay); Victoria Harbour WPCP (Sturgeon Bay); Coldwater Sewage Plant (Port Severn via Coldwater River and Matchedash Bay) and; Midland Sewage Plant, Port McNicoll Sewage Plant, Elmvale Lagoon (via Wye River) and Penetanguishene Mental Health Centre WPCP (Open Severn Sound).

+ Stream and storm water loadings are variable from year to year. The percentage reduction is based on the estimated effect of best management practice. The Wye River is expected to have a greater load reduction for urban and watershed loads. Watershed load reduction targets are interim.

‡ Based on expected changes in secchi disc visibility

WPCP = Water Pollution Control Plant
CSO = combined sewage overflow
[TP] = total phosphorus concentration
[chl a] = chlorophyll a concentration
SDV = secchi disc visibility
Min D.O. = minimum dissolved oxygen concentration

4.2 Actions to Protect and Enhance Habitat

4.2.1 Severn Sound Tributary Rehabilitation Program

Between a third and a half of the land within the (Simcoe Uplands) is used for crop and livestock production. The Severn Sound watershed is drained by 6 river systems flowing through these agricultural areas. Agricultural practices and erosion have been identified as a controllable source of nutrients, especially phosphorus, in the Severn Sound.

The traditional practice of allowing livestock direct access to streams has been identified as a significant source of water pollution. It results in increased phosphorus and nitrogen load to the stream both from manure and land erosion, stream bank instability, loss of aquatic and riparian habitat and bacterial contamination. As livestock trample the banks and consume vegetation, the resulting erosion and sedimentation in the stream smother out aquatic habitat and reduce the potential of the habitat for production of aquatic and terrestrial life.

To rectify these problems, the Severn Sound Tributary Rehabilitation Project, a multi-partnered program, has been initiated. The main components of the program are: fencing to restrict livestock access; rip rap placement (stream bank stabilization using rocks); log jam removal (allowing natural stream flow); and planting trees and shrubs to accelerate stabilization and to improve fish and wildlife habitats. In many cases, all components are implemented in the same project.

A 1991 Severn Sound RAP livestock survey estimated that approximately 4,000 cattle (livestock) had direct stream access (Table 4.3). Although 28 km of fencing and rehabilitation of streams in Severn Sound has already been completed, approximately 38 km of stream needed fencing to restrict access (Figure 4.10).

Work began in 1991 and as of the fall of 1992, 15 projects involving approximately 12 km of stream have been fenced retiring 18 ha of land. This has restricted stream access for about 250 cattle. On this fenced land, 20,000 trees and shrubs were planted by volunteers and planting will continue in 1993. Log jams have been removed along 4 km of the Wye River in cooperation with Tiny Township. Plaques have been awarded to partners, especially landowners, to acknowledge their efforts to improve the environment of Severn Sound. Four hundred tonnes of rip rap was placed along eroding portions of the Wye River.

The Severn Sound Tributary Rehabilitation and Erosion Control Project will help to improve water quality in the Severn Sound by improving tributary stream quality. The decrease in phosphorus input will reduce the growth of nuisance algae. Stream bank stabilization will prevent siltation and will in turn protect valuable aquatic habitat and slow the unnatural decrease in channel capacity. The new stream bank tree and shrub growth will shade the stream and lower its temperature, creating improved conditions for insects fish consume and for diverse wildlife. Many fish species (ie. trout) thrive under these

improved stream conditions. The presence of sensitive species such as brook trout is a good barometer of overall stream "health". Restricting direct livestock access will also improve livestock herd health by reducing the probability of waterborne disease (ie. Leptospirosis, Salmonellosis, Mastitis and Bovine virus diarrhea).

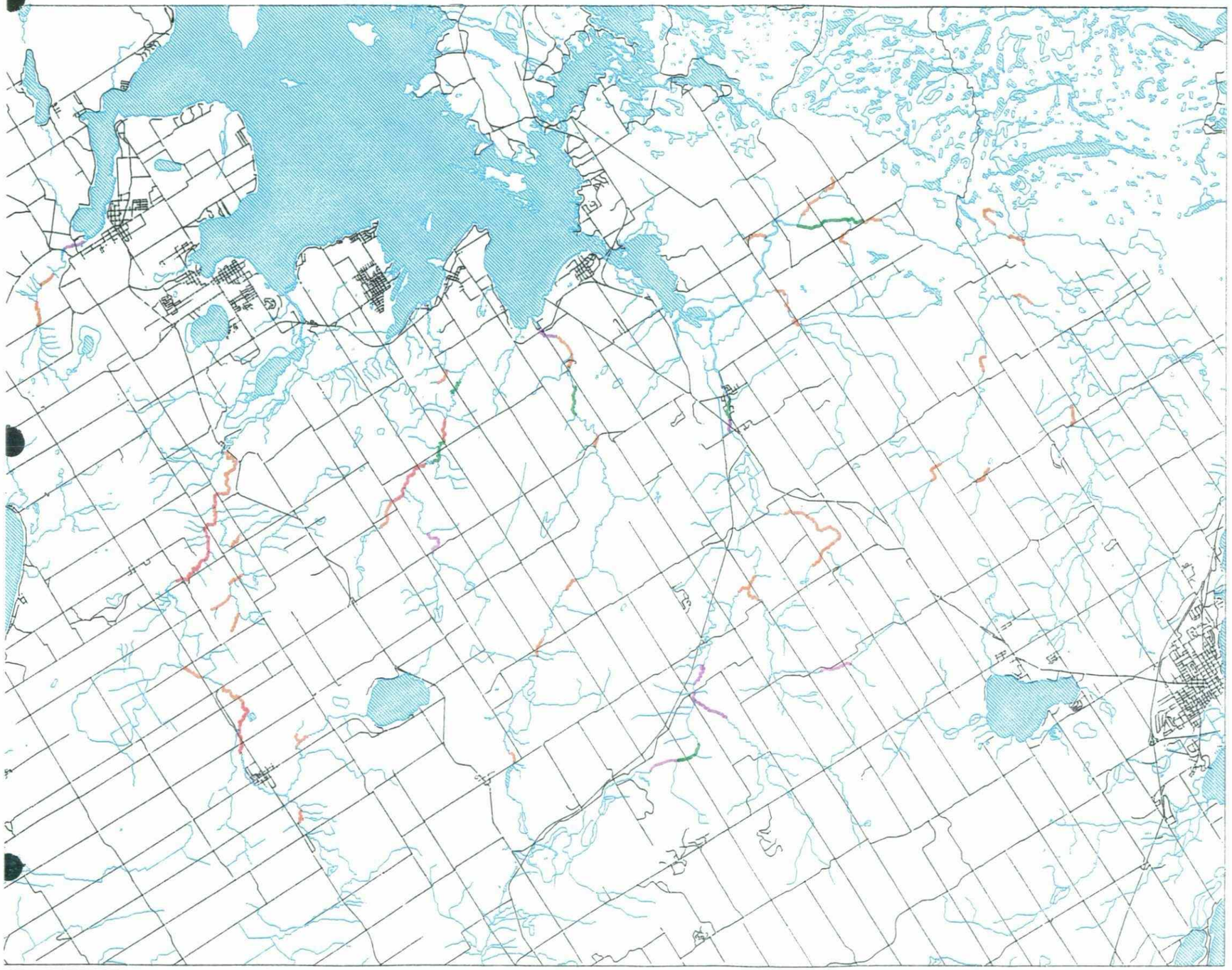
Figure 4.10:

SEVERN SOUND WATERSHED

TRIBUTARY REHABILITATION PROGRAM

1991 - 1992

SCALE 1:150,000



SEVERN SOUND REMEDIAL ACTION PLAN
11 KM

ONTARIO MINISTRY OF NATURAL RESOURCES
2 KM

COMMUNITY FISHERIES INVOLVEMENT PROGRAM
9 KM

AREAS THAT REQUIRE REHABILITATION
38 KM

SEVERN SOUND

MAF G.I.S

4.2.2 Coastal Habitat Rehabilitation

The Effects of Shoreline Activities on Coastal Fish Habitat

With increased development along the shoreline and tributaries of Severn Sound comes an increased threat to near shore fish habitat. When habitats are altered or eliminated, the capacity of Severn Sound to sustain a balanced and naturally reproducing fish community is reduced. The loss or destruction of habitat during any life stages could contribute to adverse changes in the fish community, especially reduction of major predators such as northern pike, muskellunge and walleye. Several areas of wetland, important for pike spawning, have already been lost to shoreline development and black crappie numbers have increased. If the spawning habitat of predator fish species is destroyed, their numbers will decline and prey species will over populate. Wetland habitat loss also impacts wildlife populations.

Habitat can also be destroyed needlessly through a fragmented approach to managing the nearshore waters of Severn Sound. Integration of the planning efforts of federal, provincial and municipal governments into a management plan is vital.

With increased development along the South shoreline of Severn Sound, in particular Penetanguishene, Midland and Hog Bays, the nature of the nearshore habitat has changed. In other areas such as Matchedash Bay and the North Shore there has been less alteration. For example, wetland habitats have decreased by 68% and 18% in Penetanguishene and Hog Bays respectively since 1951 (V. Cairns, unpublished).

The existing docking or number of boatslips in Severn Sound has reached 4,453 (MNR, 1991) and is increasing with 1,360 proposed additional slips presently under review (Appendix 4.4). An historical review of air photos of Penetanguishene Bay shows a rapid increase in the number of slips in recent years (V. Cairns, unpublished).

Shoreline activities in the Severn Sound watershed include several one-time or infrequent larger undertakings both along the shoreline and on tributaries flowing into the Sound:

- marina expansion and development (filling and dredging)
- large municipal or private docks
- construction of water intakes/sewage plant outfalls
- construction of dams
- water crossings: culverts, bridges, pipelines, transmission lines
- drains under the Drainage Act

Large construction government funded projects such as bridges or sewage plant outfalls are considered as part of an undertaking under the Environmental Assessment Act and the Fisheries Act and require site specific studies describing existing habitat, means of mitigating

the impacts on the fish community during construction and after the work is completed, and possible compensation if habitat will be lost.

In addition, there are a number of smaller scale works undertaken by individual shoreline owners and developers. During 1990 and 1991 (Appendix 4.5), MNR issued 189 work permits for activities on or near the waters of Severn Sound. Works could destroy rare or critical fish habitats or have minimal effects to abundant habitats. Although no one project impacts extensive habitat, the cumulative effect of many individual small projects may significantly influence nearshore habitat. Project review, knowledge of fish habitats and mitigation of impacts are required to maintain habitats for fish and allow sustainable development of shorelines.

Fish Habitat Concerns

Sufficient information about fish habitats in Severn Sound is only available to develop an interim fish habitat management plan that can be scientifically defensible. The locations of walleye spawning habitats are well known and their significance is accepted by conservationists, planners and developers. The locations of major wetlands are known along the South shore but require additional investigation along the North shore. Data gathered to date supports the importance of these areas as spawning and especially nursery habitats for a large number of fish species. Other areas of near shore aquatic vegetation have also proved productive to fish, especially to young-of-the-year in investigations completed to date.

The protection of northern pike and muskellunge spawning habitats is more difficult. They seem generally associated with areas of aquatic vegetation but little information is available for northern pike and muskellunge. OMNR and Muskies Canada volunteers continue to search the North shore each spring for spawning adults. While many observations have been made, the documentation is far from complete. The situation with the bass species is similar; some spawning data have been collected but more are needed.

A fish habitat plan that protects critical habitats for scarcer species of the fish community, especially predators, and recognizes the significance of areas of aquatic vegetation while recognizing the potential for habitat creation in degraded areas will go a long way to achieving the Severn Sound RAP Water Use Goal #2, "The fish and water-based wildlife habitats in Severn Sound should be protected to maintain their healthy, naturally reproducing communities".

There is good agreement among fisheries biologists, local fishing industry operators and residents that harmful alterations of unique and essential habitats, such as wetlands, tributary mouths and spawning beds, will seriously affect the fish community. Those areas where the natural littoral zone vanished behind sheet pilings and shoreline recreational development represent opportunities to restore and develop habitat. The remainder of Severn Sound shoreline lies somewhere between these extremes either due to lack of information on habitat or due to a lower sensitivity of the fish community to shoreline

alteration in these areas.
The challenge therefore is to protect and enhance fish habitat in the nearshore areas of Severn Sound. The overall targets of the interim fish habitat management plan, in accord with the Severn Sound RAP goals include:

1. No further loss of unique and essential habitat
   - Encourage demonstration projects for habitat restoration especially in areas identified, such as Penetang Bay, and other areas recommended by fish habitat inventory studies.

2. Sustain top-level predators including walleye, northern pike, muskellunge, smallmouth bass and largemouth bass at levels similar to the 1970's with these species forming 20-30% of the total sport fish catch.

3. Promote a balanced and diverse fish community by maintaining native species' richness and abundance.

The strategy of the fish habitat management plan is to:

1. Protect those shoreline areas known to be essential. These areas will be designated ***RED AREAS*** and will have the highest restriction on development and construction activities that can alter the nearshore.

2. Encourage development of habitat in those areas where habitat was destroyed in the past. These areas will be designated ***GREEN AREAS*** and will permit alteration of the shoreline that creates or enhances nearshore habitat with the development.

3. Proceed cautiously in those areas where additional information is necessary before development can occur. These areas will be designated ***YELLOW AREAS*** and will be subject to further habitat inventory and case by case review of proposed nearshore activities.

The Severn Sound shoreline has been classified into these three categories (Figure 4.11). Staff conducting reviews of Severn Sound shoreline development or construction proposals at the federal and provincial level would consider the current category of the nearshore area and the accompanying review guidelines prior to granting approval.

Similarly, the municipalities would amend the Official Plan policies that incorporate the concerns expressed in the model amendment appended to this document (see Appendix 4.6). This would have the combined effect of providing developers and proponents with an early indication of the concerns, implications and potential limitations of different types of undertakings in proximity to the shoreline.

Activities Permitted

Activities that may take place in the nearshore areas for each shoreline area are listed in Appendix 4.7. The general guidelines provided in the MNR publication "Interim Fisheries Guidelines For Shore Alterations" should be consulted for more details. (see Severn Sound Fish Habitat Management Plan)

Review of Proposals

Under the Interim Plan, as is the case now, the Ministry of Natural Resources District Office would be the main provincial agency of contact. MNR District staff would review each proposal for shoreline development and marine construction. In addition to the case by case review, information on proposals should be compared with a running database of the shoreline in order to check on previous proposals and the state of habitat specific to the area. The classification of the shoreline (RED, GREEN, YELLOW) will govern the general concerns and general review requirements that apply while any site specific information can enhance the value of the review time in following the referral process under the Fisheries Act Policy (see Appendix 4.8).

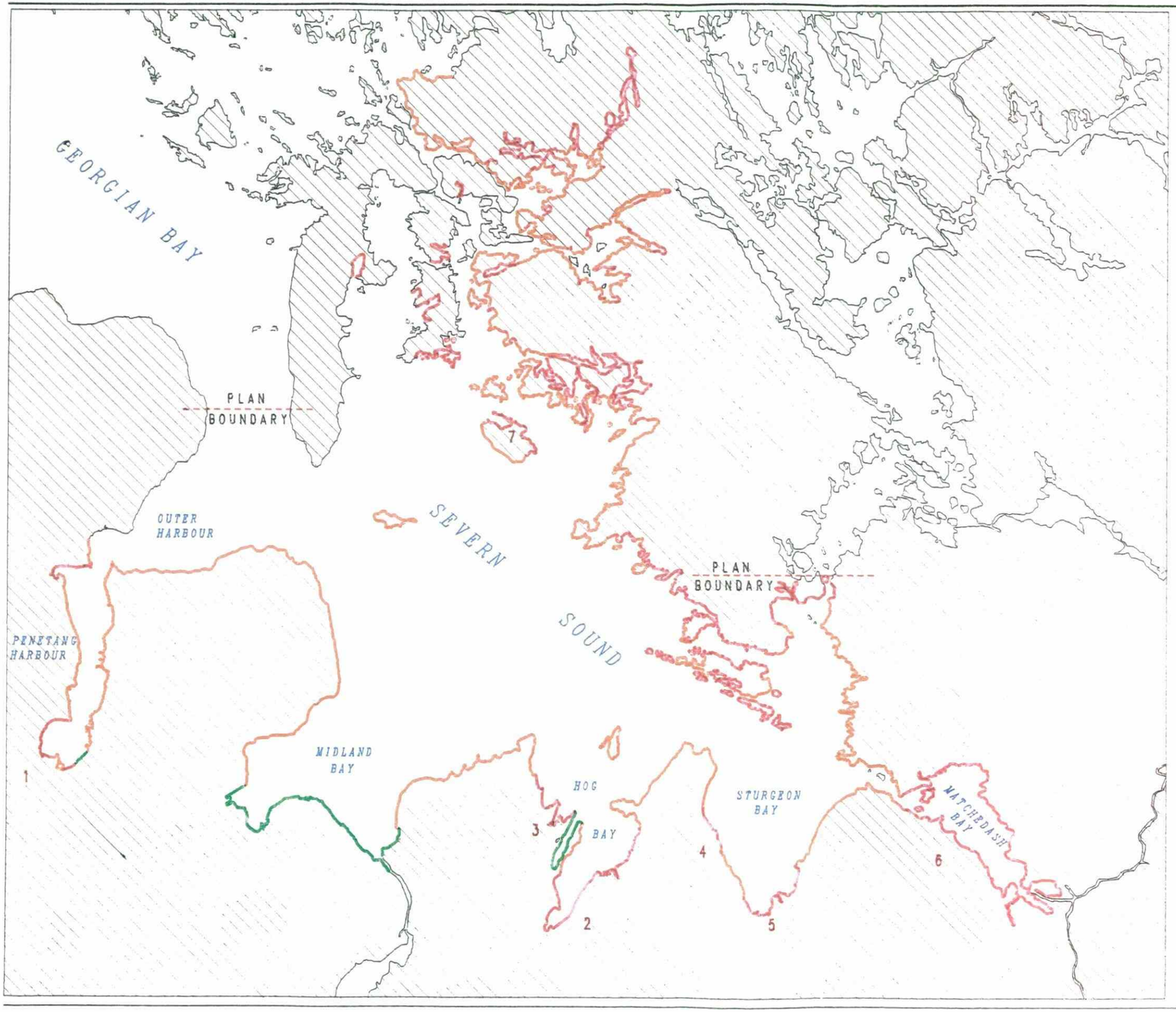
Other federal and provincial agencies will also have review concerns depending on the nature of the proposal. Transport Canada staff comment on the navigation aspects of marine construction proposals. Environment Canada and Ontario Ministry of Environment and Energy comment on proposals that involve dredging and the disposal of dredged material especially where the sediment is suspected of being contaminated.

Penetang Bay presents a different legal framework for work approvals. Although the impacts to fish habitat are similar to the rest of the Sound, the bed of the Bay is designated a Federal Harbour and therefore Provincial legislation (ie. Public Land Act) does not apply. The Federal Fisheries Act does apply, but there is presently no mechanism for the approval of small scale projects which normally are administered through the Public Lands Act. This situation needs to be resolved in order to completely implement this plan.

Figure 4.11

SEVERN SOUND FISH HABITAT MANAGEMENT PLAN - 1992

SCALE 1:90,000



- HIGHEST RESTRICTION ON DEVELOPMENT
  129 KM - 37%
- SUBJECT TO FURTHER REVIEW AND INVENTORY
  138 KM - 39%
- REHABILITATION OF HABITAT ENCOURAGED
  12 KM - 4%
- UNCLASSIFIED COASTLINE
  72 KM - 20%

IDENTIFIED WETLANDS

1-PENETANG BAY MARSH -CLASS 3
2-HOG BAY MARSH -CLASS 3
3-PORT MCNICOLL MARSH -CLASS 2
4-VICTORIA HARBOUR MARSH -CLASS 3
5-STURGEON BAY MARSH -CLASS 2
6-MATCHEDASH BAY MARSH -CLASS 1
7-QUARRY ISLAND MARSH -CLASS 3

4.2.2 Matchedash Bay Project

The Matchedash Bay Project of the Eastern Habitat Joint Venture North American Waterfowl Management Plan is part of an international effort between Canada and the United States to preserve and restore waterfowl populations and habitat in key areas of North America. The Matchedash Bay area, located in the South Eastern end of Severn Sound, was selected because it:

- is a high risk area for wetland habitat loss
- has high potential for the production of waterfowl and other wetland-dependent wildlife
- is a critical staging area for migrating waterfowl
- is highly compatible with other existing wetland values and uses.

The Project goals/targets include:

- Secure and manage 1,715 ha of wildlife habitat and integrate other important resource interests.
- Restore and develop 1,427 ha of habitat for waterfowl and other wetland-dependant wildlife.
- Increase waterfowl production in the flyway through maintaining and enhancing 442 ha of habitat for staging waterfowl.
- Produce annually 2,450 waterfowl, including 880 Mallard, 210 Black Duck, and 1,360 other waterfowl of various species.

4.2.3 Penetanguishene Bay Habitat Restoration Project

A rare seiche induced water level change in Severn Sound, Monday November 6, 1992, lowering the water by approximately 1 meter. As a result, several hundred acres of severely degraded fish habitat were revealed in Penetanguishene Harbour, covered by rotting lumber slabs, logs and saw dust from the lumbering area prior to the 1930's. The depth of rotting material is unknown. Options for remedial actions would require initial study because of the uncertain effects of excavation on bay quality. Phase 1 of the project would involve a study to support the preferred course of action. Phase 2 which could start in 1993/94 may consist of a shoreline cleanup weekend involving the public and the Town of Penetanguishene.

4.3 Preventing Contamination

4.3.1 Municipal Industrial Strategy for Abatement

The Municipal Industrial Strategy for Abatement (MISA) is an Ontario Ministry of the Environment and Energy regulatory program with the goal of virtual elimination of municipal and industrial discharges of persistent toxic chemicals to Ontario waterways. The municipal sewer use and sewage treatment aspects of MISA apply to the Severn Sound RAP as there is only one direct industrial discharger in the Severn Sound area (Mitsubishi).

Sewer Use Control

The MISA Sewer Use Control Program proposes to protect waterways by reducing toxic-contaminated wastewater discharges. The environmental concerns addressed by the program include:

- the health of sewage plant workers
- the potential for toxic contaminants to pass through the sewage plant to the receiving water
- the adverse effects of toxic contaminants on the treatment process or the sewers
- contamination of sewage sludge
- the potential effects of spills of toxic contaminants

Under the program, regulation of indirect industrial discharges to municipal sewers will occur in four stages.

1. municipalities will be expected to pass new sewer use by-laws which specifically regulate toxic chemicals
2. Municipalities will be required to compile inventories of sewer dischargers and devise procedures for dealing with new dischargers as they arise
3. MOEE will pass provincial limits regulations which distinguish between 22 industrial sectors.
4. Municipalities will be expected to pass further sewer use by-laws which provide special discharge limits where local impacts are not addressed by the provincial regulations.

The action required of industries would include: process changes, substitution of raw materials, recycling of process wastes, pre-treatment of waste streams prior to discharge to the sewers and treatment of industrial sludges at source. Homeowners are also involved in preventing contamination of Severn Sound by preventing household hazardous or toxic substances from entering the sewers.

The implementation of the MISA Sewer Use Control Program is under way. Municipalities

with larger sewage plants and significant indirect industrial dischargers are being addressed first. The Town of Midland and the Town of Penetanguishene are included in this first group of some 75 municipalities. In the smaller municipalities (including Elmvale, Port McNicoll, Victoria Harbour and Coldwater) MOEE will have surveys completed of the sewage system and the potential indirect industrial discharges. Depending on the results of these surveys, specific contaminants may be identified for specific municipalities to address in local bylaws.

Sewage Treatment

The MISA Municipal Program intends to produce a regulation which will significantly reduce pollutant loadings from municipal sewage treatment plants (STPs) in the immediate term and eliminate effluents that can kill fish in the longer term.

The three conventional parameters are used to measure the degree of pollution as well as the effectiveness of municipal sewage treatment. Specifically, BOD is a gross indicator of the amount of organic chemicals in the sewage. Suspended solids affect the aesthetics of the sewage being discharged, and many metals are trapped with the solids. Total phosphorus is a major pollutant contributing to algal bloom in lakes and rivers. Ammonia is a by-product of protein related matters such as human faeces. Except for meat packaging and dairy industries, ammonia is primarily contributed by sanitary sewage. Chlorine is added at the STP for disinfection purpose. While most STPs receive wastewater from industries and commercial establishments (up to 40%), residential sanitary sewage is a major contributor of pollutants including many metals and toxic organics.

A survey study of 10 Ontario STPs (one of which was the Midland WPCP) indicated that ammonia and chlorine concentrations in most STP effluents are sufficient to kill fish, unless the effluent is immediately diluted between 2 to 10 times (MOE, 1992). The concentrations of metals and toxic organics such as solvents and pesticides in most STP effluents can affect the health and growth of fish, but are not sufficient to kill fish.

To remove ammonia, a large majority of the secondary and tertiary STPs in Ontario have to expand their plant sizes and double the amount of air supplied to the biological treatment process. Lagoons have to be expanded to provide 360 days retention to effect ammonia removal.

With respect to chlorine toxicity, primary, secondary and tertiary plants must disinfect their effluent at least in the summer before discharge. Only 5% of the plants use ultra-violet light irradiation process - a process that leaves no residual toxicity. The other plants use chlorine for disinfection and a residual chlorine (a toxic substance) is present in the discharge. The ultra-violet light irradiation process is not widely used because it was developed only recently in early 1980s. The ultra-violet light irradiation process is also less versatile than chlorine and can be significantly more expensive at large STPs. Lagoon effluent is discharged without disinfection because of the long retention time. Pathogenic bacteria die-

off naturally in less than 30 days.

Unless site-specific limits are stipulated in the Certificates of Approval (Cs of A), sewage plants are assessed by policy guidelines based on annual average concentrations for BOD and suspended solids and monthly average concentration for total phosphorus. Ontario policy guidelines for BOD, suspended solids are 25 mg/l and 25 mg/l based on annual average concentration and 1 mg/l total phosphorus concentration based on monthly average.

The MISA STP program proposes the following:

- defer the requirement of removing toxicity to fish (i.e. not to set limits for ammonia and chlorine residual) in the STP effluent until low cost alternatives can be developed to retrofit Ontario STPs;

- phase out primary treatment in 20 years (Severn Sound area plants already provide secondary or tertiary treatment);

- develqp a STP regulation which stipulates effluent limits;

- include a package of pollution prevention initiatives. Some initiatives will be stipulated in the regulation while others will be implemented through incentive programs.

Promulgation of STP Effluent Limits Regulation

In consultation with municipal representatives, MOEE will promulgate effluent limits for the 3 conventional parameters (BOD, suspended solids and total phosphorus) based on historical effluent quality data achievable by the secondary and lagoon treatment systems used in Ontario. The present policy allowing MOEE to set more stringent site-specific effluent limits to protect local receiving water will continue be applicable in the future. This policy applies to the Severn Sound area plants as explained in Section 4.1 for phosphorus removal.

Pollution Prevention Initiatives

Major pollution initiatives proposed include but are not limited to:

- promulgating a mandatory "STP Operator Certification" program and an "Enhanced Operator Training" program, to ensure STPs are operated by qualified and well trained people;

- adapting the "Compliance Maintenance Program" initiated by the Wisconsin State and adapted by several other States. Under this program, municipalities are required annually to evaluate their plant performance and report on the actions they will be taking to keep their STPs in compliance with their effluent limits in the next 3 to 5 years;

- introducing a STP optimization program which will train consulting engineers and staff of large municipalities to optimize their plant existing treatment processes and operations, thus discouraging "unnecessary" capital expansion. Provide either technical or financial assistance to the small municipalities to perform optimization;

- progressively shifting the MOEE capital funds to assist municipalities which take pro-active actions to maintain compliance;

- introducing a "Water Efficient" program which will encourage and assist municipalities to practise water conservation and better management of their sewer infra-structures. The program will contain financial incentives (or disincentives for not practising water efficiency) and educational programs.

The MISA STP program described above is under discussion within the Ministry of the Environment and Energy. Many of these initiatives have been considered and are being implemented in the Severn Sound area. For example, the Town of Midland has an ongoing sewer use program that is leading to the reduction of metals in sewage plant sludge. The Town is also conducting a process audit and optimization study in partnership with MOEE and the Environment Canada Great Lakes Cleanup Fund.

4.3.2 Other Issues of Concern

The RAP Team has assessed the contaminant status of Severn Sound with respect to water uses. Household and industrial hazardous substances have the potential to gain access to the environment through inappropriate use or spills. Several concerns have been expressed by PAC members and are being accepted by other government programs to prevent or address potential contaminant problems in the Severn Sound area. Some of these issues are listed as follows:

1. The Sierra Club (represented on the PAC) provided a list of environmentally friendly alternatives to household hazardous or phosphate products in 1989. The RAP facilitator, the Wye Marsh Wildlife Centre, has also acted as a clearinghouse for government pamphlets, booklets and other educational materials that deal with alternatives to hazardous or phosphate products.

2. Amnesties for hazardous household waste have been held in the area as part of the North Simcoe Waste Management Association's and municipalities' initiatives.

3. Waterfowl deliberately ingest small bits of stone or grit to aid in the breakdown and digestion of these coarse materials. Unfortunately in a wetland that has been hunted they will also ingest lead pellets from shotgun shells. Lead is a toxic substance. Large doses may cause death within several days. Smaller doses cause disruptions in the digestive system that lead to starvation as well as neurological damage. Lead is not only available from spent shotgun shells but also from lead shot sinkers used for fishing. The Wye Marsh Wildlife Centre has started a program with three goals: 1) promote public and hunter awareness of the potential of spent lead shot to cause waterfowl mortality, 2) inform hunters about alternate shot types and 3) encourage hunters to use alternate shot types.

4. Use of herbicides to treat rooted aquatic plants. The PAC, as requested by those attending public meetings (held September 1989), passed a resolution opposing the use of herbicide for the control of rooted aquatic plants in the Severn Sound area. There is also concern for the use of herbicides on land near the shoreline of the Sound.

5. Concern over contaminant migration from closed landfill sites near the Severn Sound shoreline (south end of Penetang Bay at Copeland Creek and Tiffin Park at Tiffin Basin) have been expressed. To date MOEE sampling and biomonitoring programs have shown no surface water impacts of landfill sites. This area, however, warrants ongoing investigation by the MOEE.

Many of these and other issues with contamination of Severn Sound will involve ongoing dialogue amongst the public, the regulatory agencies and/or manufacturers to ensure that Severn Sound remains free of contaminant effects.

4.4 Planning and the RAP

Much of the environmental stress to the quality of the Sound relates to the adverse effects of development occurring on the shoreline and in the immediate watershed draining to the Sound. In order to sustain cleanup efforts and the principles behind them, it is clear that recognition of the RAP goals, principles and objectives must be made in the local planning process and in provincial plan review under the Planning Act.

A major shift in planning concepts is necessary to accomplish the actions in the RAP and to ensure that they are sustained. The watershed boundary is most appropriate for environmental quality management but this boundary is seldom mentioned in planning documents which are based on political boundaries. The Georgian Bay Association (represented on the Severn Sound PAC) calls for "water based" zoning and planning to acknowledge a "water-based" community that is dependant on boating along the North Shore of Severn Sound and the eastern Georgian Bay Coast.

The concept of a model official plan amendment to incorporate Severn Sound Remedial Action Plan concerns into local area (north Simcoe County and Georgian Bay Township) planning documents has been discussed with area planners from the 15 Severn Sound municipalities and provincial review agencies. The working draft of the model amendment is provided in Appendix 4.6.

The advantage of the amendment to the municipalities is that a much simpler process could be followed (resolution in Council?) to adopt the amendment rather than have each municipality draft their own amendment and go through an individual review and approval process. In follow up to the amendment, bylaws would have to be passed by participating municipalities.

The other concerns related to planning that have arisen during the development of the RAP are discussed below.

Simcoe County Restructuring

Simcoe County will amalgamate and restructure municipalities within the Severn Sound with a target date of 1994. This will result in a reduction in the number of municipalities from 12 to 8 within the Severn Sound area. Policy matters for planning and waste management will become the responsibility of the County. Sewage treatment, however, will remain the responsibility of the local municipalities. Municipalities with and without communal sewage servicing will, by necessity, need to come to agreement on disposal of septage and holding waste. Municipalities with servicing will have to develop mechanisms and facilities to receive this waste from other municipalities.

Jurisdiction over the waters and bed of Severn Sound

The majority of the bed of Severn Sound is termed provincial crown land. The provincial legislation that plans and controls activities that could adversely affect environmental quality applies to these areas.

There are also privately owned lands especially where water lots were deeded to municipalities or individuals in the 1800's and early 1900's. The majority of Penetanguishene Bay is termed Federal Crown land. These areas are not as clearly subject to the legislation that is designed to prevent activities that adversely affect environmental quality.

In Severn Sound area the greatest source of jurisdictional confusion arises in marine construction activities such as building docks, marinas and filling. The federal government administers the Navigable Waters Protection Act which requires an exemption to build a structure or to dredge while the Provincial Public Lands Act requires a permit for activities carried out in water. There is a need for a federal/provincial agreement (even on a local basis) for the efficient and coordinated handling of marine construction proposals. One option is the creation of a sub-agreement under the Canada Ontario Fisheries Agreement to deal with reconciliation of legislation and development of infrastructure and protocols associated with marine construction.

5. SOME SOCIO-ECONOMIC CONSIDERATIONS OF THE SEVERN SOUND RAP

The Severn Sound RAP is at a stage where the approximate costs for clean-up are known but the detailed financial arrangements for implementation require more discussion during the implementation phase. For instance, general storm water costs, included below will require detailed study before final costs are available. Cost-sharing arrangements between the province and the municipalities for sewage plant upgrades are presently under review and may change. While still preliminary, this section begins to address these questions, the answers to which are critical to making clean-up a reality.

This section addresses a number of points including the cost of remediation, cost-effectiveness, the potential funding combinations and the implications to the community. The description of potential cost-sharing arrangements outlined here is preliminary and not exhaustive. They are based on existing areas of jurisdiction and assume that existing provincial funding programs continue. The intent is solely to explore and identify possible options for funding the RAP. Also, ability to pay is assessed by comparing RAP costs with other forms of taxation and municipal spending. The principles of beneficiary and polluter pay are examined, other funding options outlined and the anticipated benefits from RAP implementation assessed.

5.1 Summary of Costs by RAP activity

Costs have been estimated for many of the phosphorus control actions (Table 5.1).

Capital costs of sewage plant upgrades, shown in Table 5.1, incorporate the expected growth in population and the target effluent phosphorus concentration from Table 4.1. The first three plants in order have already received funding commitment while the remaining plants require final design and cost estimates. The most expensive upgrade estimated will be the new Elmvale sewage plant for which funding has already been committed. This is because a high degree of phosphorus removal and a completely new plant is required to achieve a low effluent phosphorus concentration in order to improve and protect the quality of the Wye River. The Midland plant upgrade (final design not completed) may only require upgrade of some components of the existing plant following the results of a plant optimization study presently under way. With minor additional cost the existing Victoria Harbour plant will meet the RAP effluent phosphorus target as the existing plant already includes tertiary phosphorus removal. At present, capital costs for these projects would be born by the provincial government and the local municipality. Funding mechanism are presently under review.

Replacing faulty private shoreline septic tank and tile bed systems will cost an average of $5,000 per system. The Severn Sound RAP shoreline pollution survey has shown that up to 20% of the 3,000 shoreline systems require replacement. The responsibility for maintaining and replacing systems remains with the landowner. A combined total of up to $3,000,000 may have to be spent in order to meet the RAP.

The Town of Midland has identified two pumping stations that require upgrading in order to eliminate combined sewer overflows (CSOs) and bypass of raw sewage to Severn Sound. These upgrades have a combined cost of approximately $1,000,000. Urban storm water treatment costs were not based on local cost estimates but rather were based on very general assumptions of Hickling (1992). The $35,000,000 cost for urban storm water treatment should be considered a rough estimate. Before this recommended remedial action is carried out, studies of best storm water management practices technology for the urban areas of Severn Sound and detailed local cost estimates should be carried out.

Table 5.1 also indicates costs for four agricultural source actions (livestock access or fencing, milkhouse washwater, septic system and manure runoff) as estimated using the provincial Clean Up Rural Beaches (CURB) model. The costs for each action are subdivided by capital cost and operation and maintenance costs. In all farming option calculations, we have assumed full provincial funding under the CURB project. A total potential cost for agricultural sources could be up to $4.1 million. These actions are the responsibility of the landowner with potential support by the CURB implementation program and the Severn Sound RAP tributary rehabilitation program, already under way in the Severn Sound watershed.

The potential total capital cost for phosphorus control is $62 million. However, more than half of the total represents a rough estimate of the cost of treating stormwater from existing urban areas. Excluding stormwater, the capital costs are $27 million. Of this amount $14 million in capital projects has been committed to date.

Table 5.1: Summary of costs by remedial action

	Capital Cost ($1,000s)	Annual Capital Cost ($1,000s/y)	Annual O&M Cost ($1,000s/y)	Total Annual Cost (1) ($1,000s/y)	Potential Phos. Reduction (kg/yr)	Cost Effect. ($/kg.yr)	Status
SEWAGE PLANT UPGRADES							
Penetang Main St	5,000	500	64	564	1,494	378	C
Penetang Fox St	500	50	27	77	498	155	C
Elmvale	7,000	700	72	772	1,878	411	C
Midland	6,400	640	344	984	2,789	353	S
Coldwater	1,460	146	40	186	1,187	157	P
Port McNicholl	1,500	150	14	164	146	1,123	P
Victoria Harbour	15	2	0	2	129	14	P
	21,875			2,748	8,121	338	
PRIVATE SEWAGE (2)							
	3,000	300	0	300	1,488	202	P
URBAN STORM WATER							
CSO/Bypass	1,000	100		100	1,216	82	C
Storm (3)	35,000	3,500		3,500	627	5,586	S
AGRICULTURAL SOURCES (4)							
Milkhouse	159	8	12	20	1,680	14	C
Manure storage	2,873	144	79	222		333	C
Fencing	900	45	45	90		94	C
Rural septic	218	22	5	27	108	115	C

Notes (1) See notes on Table 4.1
(2) Assuming 20% of 3,000 systems need replacement @$5K each
(3) Assuming 20% potential reduction in phosphorus load, costs using unit storm costs and areas from Hickling (1992)
(4) Assuming 20% potential reduction in phosphorus load. Individual costs have been multiplied by the number of sites needing remediation. See Table 4.3 and Appendicies 4.1 and 5.3
C = funding committed
S = study underway toward final design
P = planned, no approved design or funding

5.2 Cost-Effectiveness Analysis

Table 5.1 includes the application of the phosphorus control strategy and a comparison of the cost-effectiveness of phosphorus control actions. Cost-effectiveness analysis provides some indication of the dollar value required for each kilogram of phosphorus removed, to assist in prioritizing remedial actions for implementation.

The cost effectiveness for sewage plant upgrades range over two orders of magnitude from $14 to $1,123 per kg of phosphorus removed per year ($/kg.yr, see Table 5.1). The overall cost effectiveness is $338 /kg.y. The upgrade for Port McNicoll will be the least cost effective sewage plant upgrade because the plant is presently approaching the RAP effluent phosphorus objective and only requires expansion. The minor upgrade for the Victoria Harbour sewage plant is the most cost effective. The cost-effectiveness for Midland sewage plant, $353/kg.y, ranks 4th amongst the sewage plant upgrades while achieving the largest phosphorus load reduction (2,789 kg/y).

Compared to the sewage plants the cost effectiveness of private sewage systems is slightly more favourable. The value of $202 /kg.y assumes that 80% of the phosphorus is removed by the system. The phosphorus removal efficiency is considered to be much less effective on the thin, granular soils of the north shore of Severn Sound where cost effectiveness would be less favourable.

The upgrade of the Town of Midland's sewage pumping stations to eliminate the combined sewer overflows and the bypass of raw sewage into Severn Sound has a very favourable cost effectiveness ($82 /kg.y).

The cost effectiveness for agricultural sources (based on Hayman, 1989), other than targeted soil conservation measures, indicates that directing milkhouse washwater to treatment is the most cost effective action followed by restricting cattle access by fencing, upgrading rural septic systems and constructing manure storage facilities.

Based on the overall comparison of cost effectiveness, the treatment of milkhouse waste is the most cost effective action for controlling phosphorus. The next most cost effective action is the upgrade of sewage plant pumping stations and some sewage plant upgrades.

5.3 RAP Costs in the Context of Municipal Spending

Appendix 4.9 highlights the potential cost-sharing arrangements, by community for four effluent quality scenarios, for the sewage plant upgrades in the Severn Sound area. For instance, in the Town of Penetanguishene, to achieve effluent concentrations of less than 0.1mg/LTP, which may be necessary to maintain the desired open water phosphorus concentration in Penetang Bay, the capital cost is estimated at approximately $5.5 million (Reid and Associates, 1992 estimate) or $550,000 per year over 10 years (simple amortization without discount). If full provincial funding of approximately 49% is obtained,

the associated capital cost, to the municipality would be approximately $391,900 per annum over 10 years. With additional operation and maintenance costs, the total annual cost to the Town would be $532,700 (capital + O&M). For comparison purposes, this translates to an annual per capita cost in the Town of Penetanguishene of $80.

For further illustration, to achieve the RAP objective for effluent phosphorus concentration of less than 0.15 mg/LTP at Victoria Harbour, the total cost is estimated at approximately $1,510 or $151 per year over 10 years. Given the population of Victoria Harbour, the potential full provincial funding of approximately 77% may be obtained. Consequently the associated capital costs to the municipality would be approximately $347. Including O&M, the total annual cost to Victoria Harbour would be $85. For some indication of affordability, this translates to an annual per capita cost in Victoria Harbour of less than $1. It should be noted that the existing funding formula used is under review by the provincial government and may change.

Figure 5.1 illustrates that the Village of Victoria Harbour spends more than $2.2 million per year, or approximately $1,127 per resident per year. In 1992 Victoria Harbour allocated approximately 70% of total consolidated (operations and maintenance + capital) expenditure on such items as roadways, social services etc., 26% on education, while 4% was transferred to the county. Compared to this total consolidated municipal expenditure, the annual cost to upgrade the STP to achieve effluent concentrations of less than 0.15 mg/L TP, would be less than $1 per capita or less than 0.09% of per capita municipal expenditures. Appendix 5.2 provides an indication of the affordability of sewage plant projects in relation to municipal consolidated expenditures for the other communities in Severn Sound.

In the past 10 years, there have been measurable increases in municipal spending. For instance in the Town of Midland, the 1992 budgeted expenditure is 68% higher than in 1988 and 138% higher than in 1983. After adjusting for inflation, these increases from 1988-1992 and 1983-1992 are still 46% and 72% respectively (Figure 5.2). To recover the municipal costs of STP upgrades consolidated expenditure would have to increase by approximately 6% per year for 10 years. This assumes that no municipal monies are already allocated to STP-RAP related options. For the purpose of comparison, Appendix 4.10 shows similar patterns for the other municipalities within the Severn Sound AOC.

Table 5.2 provides an indication of potential impact of phosphorus control actions on area households and also compares the cost of the RAP to current municipal expenditures (on water, sewage and waste) and to current sewer and water bills for selected communities in Severn Sound.

Table 5.2:

POTENTIAL IMPACT OF SEVERN SOUND RAP ON AREA HOUSEHOLDS

(annual cost to the household)

	Town of Midland	Town of Penetang-uishene	Village of Elmvale	Village of Victoria Harbour	Tay Twp. farm (5)	Georgian Bay Twp. Cottage
Sewage Plants (1)	$182	$173	$351	$1		
Private Systems (2)					$285	$535
Urban Stormwater						
CSO/Bypass (3)	$22		$38			
Storm Areas (4)	$332	$161	$461	$388		
Watersheds					$880	
Habitat Rehab (6)						$10
Total all actions	$536	$334	$850	$389	$1,165	$545
Total - new storm	$204	$173	$389	$1	$1,165	$545
Current Munic. Expenditure	$447	$554	$526	$508	$108	
Current Sewer & Water Bill	$244	$238	$173	$288		

Notes:

(1) Costs include both additional treatment for RAP and absic expanded plant

(2) Assumes septic must be replaced (ONLY 20%); farm septic replacements are subsidized under CURB; and maintencance cost of $35/yr for all systems

(3) Projects to eliminate bypassing at pumping stations and combined sewer overflows

(4) Assuming $25,000/ha for stormwater treatment (Hickling, 1992) Note - Revised Estimates Under Preparation

(5) NOTE THIS IS A WORST CASE EXAMPLE SHOWING THE MAXIMUM IMPACT OF A LIVESTOCK OPERATION

(6) Assumes shoreland owner spends $10/yr to plant trees, shrubs and habitat enhancement

5.4 Financing Remedial Actions

Sewage Plant Upgrades

The normal route of financing municipal expenditures is through collecting property taxes. While the town receives funds from other sources, property taxes fundamentally define the level of spending that occurs.

As mentioned in Section 5.3, property taxation has increased about 5% per year more than the average inflation level in the Town of Midland over the 12 year period from 1979 to 1991 (Figure 5.3). Much of this increase in Midland, as with many other municipalities in Ontario, is a result of the increasing cost (particularly servicing costs) of accommodating growth. Municipal budgets are being strained by the need to provide additional services (water supply, wastewater, roads, schools, recreation, etc.).

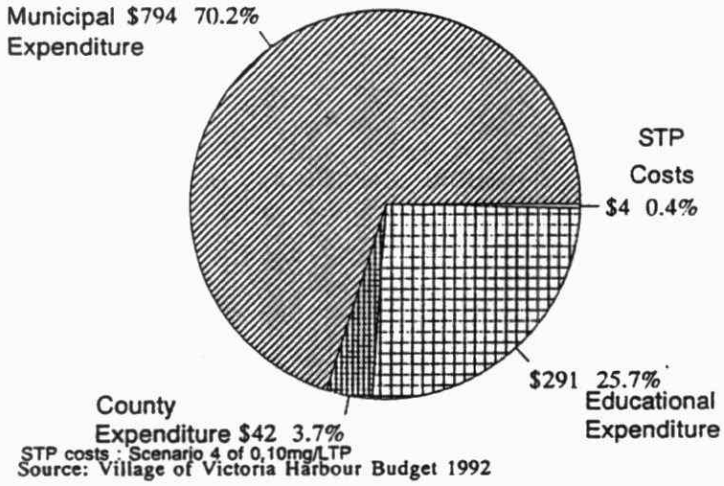
Consequently, the choice between retaining undeveloped lands as open space and urban expansion is becoming increasingly difficult. For instance, the perceived notion that urban expansion has a positive real effect on the tax base is not always the case. In fact, a growing body of literature indicates that the cost of expansion often outweighs the revenues to local governments resulting from the expanded tax base (Crain, 1988; Larson and Vance, 1988; American Farmland Trust, 1986).

Furthermore, different development densities or land use forms have different impacts on servicing costs (American Farmland Trust, 1986; IBI, 1990). A study in Loudoun County, VA, indicated that "over a wide range of development densities ... the ongoing public costs of new residential development will exceed the (public) revenues from such development." Of those units analyzed, annual revenues per thousand dwellings were between $2.7 million and $2.9 million, while costs averaged between $3.5 and $5 million. The annual net deficit per thousand units ranged from $0.6 million to $2.3 million (1986 dollars). The greatest predicted shortfall was for the lowest-density - termed by the Trust as "rural sprawl". The least shortfall was for medium density development (AFT, 1986). Similar conclusions have been drawn from Ontario case studies (IBI, 1990).

In short and with respect to the RAP, financing the upgrading of sewage plants in many municipalities in the Severn Sound AOC has become a great burden on finances, taxation and on taxpayers.

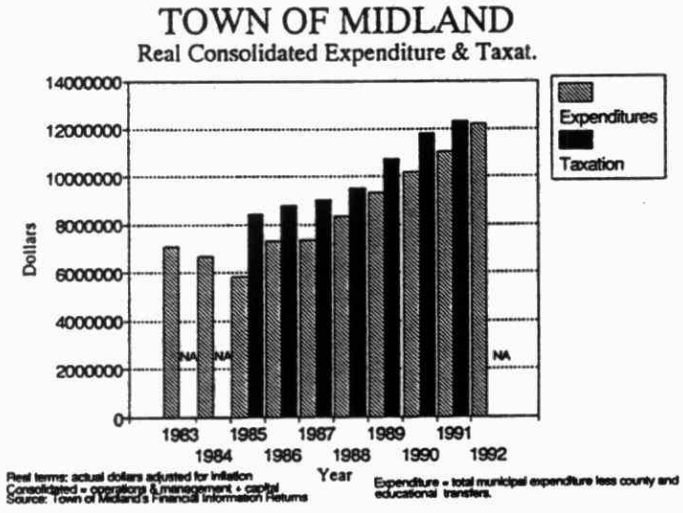
An alternative, more equitable and sustainable approach that puts less burden on tax increases, is the increased use of user fees, such as water and sewage rates, and full cost pricing. Full cost pricing is viewed as including the cost of construction, operation and maintenance, renovation, and external costs (such as pollution) (Tate,1990; Rawson,1990; Fortin and Mitchell,1990).

Figure 5.1: STP Costs in Relation to Municipal Per Capita Expenditures
Village of Victoria Harbour



STP costs : Scenario 4 of 0,10mg/LTP
Source: Village of Victoria Harbour Budget 1992

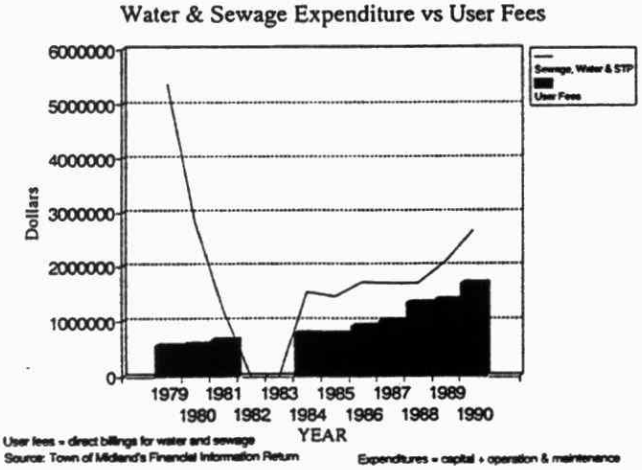
Figure 5.2:



Real terms: actual dollars adjusted for inflation
Consolidated = operations & management + capital
Source: Town of Midland's Financial Information Returns

Expenditure = total municipal expenditure less county and educational transfers.

Figure 5.3:



User fees = direct billings for water and sewage
Source: Town of Midland's Financial Information Return

Expenditures = capital + operation & maintenance

For the purposes of illustration, the Town of Midland's current average household water consumption level is $44m^3$ per month (Town of Midland, Jan. 1992), compared to the provincial average of $28m^3$ per month. The Town is fully metered and has already initiated some rate charges. However, the high level of water consumption is likely related to the average monthly household water charge of $12.30, which is well below even the 1989 provincial average.

The normal rate structure utilized by the municipalities in Severn Sound is that of a flat rate charge. Flat rate schedules levy fixed periodic, usually monthly, charges for water to consumers regardless of the volume of water used. The principal disadvantage of a flat rate structure is that it promotes excessive water use because the extra price of an additional unit of water is zero. Hence, customers have no or little incentive to conserve water, and the municipality has little control over water demand, except through administrative measures such as lawn watering restrictions.

The most progressive, equitable and sustainable rate structure is the increasing block rate structure (ie. the marginal price of water increases progressively through the blocks of the rate schedules). Under this pricing scheme, consumers have an incentive to conserve water to avoid the rates in the upper blocks.

This is not to suggest that the type of rate schedule alone will have a positive impact on reduced residential demand (Stevens, Miller and Willis, 1992). However, the ultimate price of water and the impact on one's water bill, as a result of a more progressive rate structure such as a constant or increasing block rate, does have a great deal to do with how much people demand.

For instance, if Midland were to increase the average yearly water and sewage bill from approximately $244, to the provincial average of $282 (average provincial household yearly combined rate for 28m3 in 1989), this would generate an additional $37.50 per household per year, or approximately 23 per cent of the costs of upgrading the Town of Midland's STP to a level equivalent to scenario 4 (0.10 mg/LTP). The 1992 provincial average water bill is not yet available although it is likely greater than the 1989 estimate. Consequently, bringing Midland's water rates up to the current provincial average could generate substantially more than 23 per cent of STP costs. The Town of Midland has, in fact, increased water and sewer rates in 1993 to approach full cost pricing (personal communication with Town staff).

As shown in Table 5.3, all average monthly household water rates in Severn Sound are below the 1989 provincial average. Furthermore, in Canada water rates are already extremely low and consumption very high in comparison to most other developed countries (OMOE, 1991; Tate, 1990). Because rates are low, there is often little reason for consumers to make an effort to conserve, hence the high water consumption levels.

Figure 5.3 demonstrates the Town of Midlands' shortfall between water and sewage expenditures and revenues from water bills. Like many Ontario municipalities, the full cost of supplying the service is augmented by taxation. As a result, financing during periods of high expected capital and operation and maintenance costs (such as those advocated under the RAP to meet more stringent environmental standards) becomes very burdensome on municipal budgets. Modifying water rates to include the full cost of constructing, maintaining, renovating, replacing and upgrading water supply and sewerage systems will avoid shortfalls in revenue during periods when these capital requirements are needed.

From a socio-economic perspective, full-cost pricing represents perhaps the most economically efficient and equitable mechanism for paying for the required water-related infrastructure upgrades. In the Severn Sound RAP, it is therefore important that all municipalities develop a water demand management program, including the pricing of water that reflects the full cost of providing the service.

Table 5.3: Severn Sound Water and Sewage Rates 1992 & 1989 Provincial Average

Municipality	Water Rate Structure	Monthly Water Fees	Average Monthly Water Rate	Sewage Rate Structure	Average Monthly Sewage Rate	Yearly Water + Sewage Rate
Midland	Constant + Service Charges	$4.80[1] + $2.25[2] + ($1.50/1000 Gallons)[3]	$12.30	Surcharge of 56.25% June-Oct. & 75% Oct-June	$6.92 June-Oct. $9.23 Oct.June	$244.50
Penetanguishene	Flat	$9.45	$9.45	Surcharge of 110% of water rate	$10.40	$238.20
Coldwater	Flat	$7.06	$7.06	Flat	$11.88	$227.28
Elmvale	Flat	$7.20	$7.20	Surcharge of 100% of water rate	$7.20	$172.80
Port McNicoll	Flat	$12.50	$12.50	Flat	$33.00	$546.00
Victoria Harbour	Flat	$12.00	$12.00	Flat	$12.00	$288.00
Ontario (1989)	NA	NA	$16.05 (1989 for 28m3)	NA	NA	$282.00 (1989 for 28m3)

Source: Personal Communication: Town of Midland, Town of Penetanguishene, Village of Coldwater, Village of Elmvale, Village of Port McNicoll and Village of Victoria Harbour, Tate and Lacelle (1992).

[1] Flat monthly water charge
[2] Flat monthly water service charge
[3] Constant water charge per 1000 gallons

Agricultural Clean-Up

With respect to the financing of agricultural options, assistance is possible through the provincial Clean Up Rural Beaches (CURB)[1] program. Monies are distributed to farm projects on a priority basis. If a particular farm project in Severn Sound is not of highest priority in a given year, it is eligible to apply for provincial funding in subsequent years.

The objective of the CURB Program is to identify the relative impact of pollution sources, and develop a course of action leading to the restoration and long term maintenance of acceptable water quality at provincial rural beaches. Severn Sound RAP has essentially completed the source identification and has become eligible for CURB implementation funding.

Significant enrichment and bacterial contamination in southern Ontario rivers and lakes originates from rural sources. The discharge of waste material to streams can result in elevated bacterial concentrations, nuisance algae blooms, fish kills, and present a potential health hazard to humans and livestock using the water. CURB grants, as well as grants from sources such as OMAF's Land Stewardship Program or Agriculture Canada's Permanent Cover II Program, are available to rural residents in designated watersheds to carry out projects that address upstream pollution problems. These include:

1) Restricting livestock access to watercourses,
2) Improving manure management practices,
3) Eliminating direct discharge of milkhouse wastes, and
4) Upgrading faulty septic systems

Other Funding Options and Economic Instruments for Environmental Protection

Aside from the user fee concept outlined earlier in this section, other mechanisms for funding the RAP could include effluent charges, product charges and environment funds and a variety of other funding mechanisms or tax incentive programs.

Effluent charges are payments on the direct release of pollutants into the environment. Typically this mechanism focuses on identifiable points of discharge and levies charges more often on large sources of pollutants. Charges are more broadly applied and are therefore usually administered by a provincial or federal level of government to finance individual or collective systems of pollution control.

Product charges are applied to the prices of products which create pollution as they are manufactured, consumed or disposed of. They have been used to finance collection and

[1] CURBs Funding formulas: 50% to a ceiling of $2,000 for privates sewage systems, 50% to a ceiling of $5,000 for milkhouse washwater disposal systems, 50% to a ceiling of $12,000 for manure storage/barnyard runoff controls, and 75% to a ceiling of $10,000 for livestock access restriction.

treatment systems and, as with effluent charges, are typically, although not exclusively, initiated by senior levels of government.

Private and public environment funds are usually financed through lottery revenues, voluntary contributions by individuals, corporations, etc. Monies collected are generally dedicated to habitat restoration, conservation and protection, and wildlife.

Other funding mechanisms can include: **'earmarked' taxation funds** (taxes levied on income or property used to raise revenue to fund or finance specific environmental-related projects) or the **short-term reallocation of municipal expenditures** (where some monies can be moved from certain areas to specific environment-related issues for the short-term).

Other economic mechanisms that are not necessarily funding sources but can be implemented as instruments for enhanced environmental protection include **tax incentives.** Usually, these incentives (such as credits, exemptions or deductions) can be offered to provide preferential tax treatment to encourage certain types of investment. For instance, environmental tax incentives could reduce the price of environmentally friendly activities (e.g. recycling rebates), encourage capital investment in pollution abatement and control equipment (e.g. tax credits, accelerated deductions), or lower the cost of funds for investments in environmental projects (e.g. tax-free 'green bonds').

5.5 The Benefits of Remediation

The implementation of the Severn Sound RAP will yield considerable benefits not only for the environment, but also for the economic and social makeup of the area. Identification and quantification of these benefits, where possible, is important to put the overall costs of the RAP in some perspective, to help prioritize remedial options, and to enhance the awareness of society and decision-makers of the numerous benefits that can result from commitment to RAP implementation.

The discussion of benefits here is not exhaustive, nor is the quantification of certain benefits precise. However, it does represent the best available information. The estimates provided herein do not represent the full and absolute "value" of benefits, but are rather close economic approximations given available techniques. The exact magnitude of benefits will be a function of numerous factors, the most influential of which is the extent of remediation. Ultimately, the "real" benefit or value of the RAP defies adequate quantification.

The socio-economic benefits associated with the Severn Sound RAP can include employment and income generated from expenditures on capital projects, increased recreational opportunities, a range of social benefits, increases in land values, tourism activity, and infrastructure savings.

Employment and Income Generated

The current range of potential options for remediating Severn Sound's sewage treatment plant problems could cost up to $ 21.9 million in capital expenditures alone (not including O&M). Associated with this cost, however, is the creation of jobs and the generation of income. If $15 million is spent on these STP-related options, a total of approximately 500 direct and indirect jobs would be created and $ 13.5 million in associated income generated. This estimate is based on federal and provincial guidelines that suggest the creation of 11 direct and 22 indirect person-years of employment per $1 million of capital expenditure, and an additional income multiplier for non-residential construction of 0.9. The above estimate of 500 total jobs is likely an underestimate since the projects would typically be carried out over a number of years, increasing the total cost. These jobs are one-time in nature and would not continue after capital projects are complete. The requirements of additional annual operating and maintenance (O&M) could, however, result in the need for more ongoing employment. Obviously the benefits in this area will be less if the full extent of STP remediation is not undertaken.

A similar estimate of benefits can be made for capital expenditures on the control of non-point source agricultural runoff. Currently, the total, high-end capital cost for remediation here is $4.6 million (includes the cost of fencing to restrict livestock access, treatment systems for milkhouse washwater, and improved septic and manure runoff systems). Based on this estimate, and assuming the same multipliers as above, approximately 150 direct and induced person years of employment and $ 4.2 million in additional income would be generated.

Adding the high-end capital costs for just the STP and non-point source agricultural runoff related remedial options in the Severn Sound RAP, would yield roughly 650 jobs and over $17 million in additional income generated.

Recreational Uses

Implementing remedial options will also have some impact on the opportunity and value of increased recreational activity. One study has estimated the use benefit associated with improving only a limited number of the environmental conditions under the RAP process. This study of all RAP sites indicated that in Severn Sound, remediation could result in 130,000 occasions per year in new swimming activity with an associated value of $800,000 annually (in 1989 dollars), and an increase in the use value for enhanced sportfishing of $300,000 per year (1989 dollars) (Apogee et al., 1990). In current (1992) dollars, these two benefits alone total $1.25 million annually, or $12.5 million over 10 years (the amortization period for capital STP works).

Although not quantified, there is likely significant benefit associated with the enhanced use of recreational boating and a host of other outdoor activities in the AOC. Consequently, the above estimate by no means represents the total potential recreational benefit associated with RAP implementation.

Social or Non-Use Benefits

The above referenced study also estimated the related non-use (social or intrinsic) benefits of RAPs. In Severn Sound, the non-use value associated with enhancing water aesthetics, the sportfishery and swimming totalled $ 800,000 per year (in 1989 dollars). As opposed to the above recreation estimates, the non-use estimate is the value associated solely with the satisfaction of residents knowing that the water in Severn Sound is cleaner, regardless of whether they participate or use the resource. This estimate has been obtained by approximating one's willingness to pay for cleaner water. Over 10 years, and adjusting to current dollars, this benefit could be valued at over $9 million.

These social values have been expressed in economic terms to help in demonstrating the general worth or magnitude of the benefit. Many other social benefits, although not quantified, will accrue from implementing the RAP. These include improved health; residents feeling better about the place in which they live; retaining natural ecosystems for

future generations; enhanced comfort and satisfaction by the business sector regarding the long-term future of investment and ability to attract workers; and satisfaction from the knowledge that the ecosystem is inherently safe, clean and productive even if one may never use it directly. Although in general the value of these social, intrinsic or non-use benefits is difficult to quantify, their impact is equally valid and important, and in many ways represents what the RAP process is all about.

Property Values

Although there has been no quantification, there is some rationale to suggest that the Severn Sound RAP (through improved environmental conditions, water quality, recreational opportunities, etc.) could impact land values positively.

Previous study in other locations in North America (Dornbusch and Barrager, 1973; Dornbusch et al., 1975) has resulted in a range of results. Studies at residential sites have indicated that effective pollution abatement on polluted water bodies can increase the value of single-family homes by 0% to 25%. Pollution abatement on rural land near a large water body can be positively impacted by 8% to 65%. This positive impact on property values was felt up to 4000 feet (1.2 km) away. The large range of appreciation was attributable to a number of factors or conditions. These conditions included: the specific land use type; the extent of initial degradation/contamination and duration of pollution in the water body; the breadth of subsequent clean-up; distance of property from shore; the type and size of the water body; visual and physical access; the perceived improvement; as well as a number of locational amenities (i.e. parkettes) or disamenities (i.e. industry, major transportation corridors).

A descriptive assessment of the potential impact of the Severn Sound RAP on land values can provide a number of observations. First, because of the nature of the approach utilized in RAPs (i.e. ecosystem approach, comprehensive and integrated principles), it will yield improvements not just to water quality (like previous studies), but to a range of other environmental conditions throughout and beyond the Sound. Consequently, this approach suggests that the extent of clean-up is high and the potential impact on land values is positive. Second, previous research indicates that land immediately adjacent to the Sound waters is likely to realize the greatest appreciation in value. This is not to say that waterfront owners would be the sole beneficiaries. As environmental conditions and water quality in the Severn Sound area continue to show improvement, the entire Severn Sound area could become increasingly desirable as a place to live, recreate and to do business. As a result, even land well removed from the water's edge might expect to show some appreciation. Third, there are very few, if any, disamenities significant enough in the Area Of Concern (AOC) to buffer or reduce the extent of potential appreciation.

On the other hand, because initial water quality conditions in the AOC were not excessively degraded (as compared, for example, to other AOCs), the magnitude of environmental

improvement is not as great, and the potential appreciation to land values is also less. Further, there is substantially less previous study and experience with the impact specifically on recreational land use which makes up a significant proportion of the usage of the AOC. From an initial review, however, land values could potentially increase as a result of implementing the RAP.

Tourism

Tourism is one of Ontario's most important industries. It ranks fourth in terms of export earnings and sixth in terms of its income multiplier. In 1988, direct tourism expenditure in Ontario amounted to almost $15 billion. This generated total income of $22 billion, 75,000 person-years of employment, and over $6 billion in taxes to all levels of government (MTR, 1990).

A greenway, which provides local opportunities and enhances tourist draw, can be an important asset to the community. Recent trend analyses show that weekend trips to nearby areas are on the increase, while the traditional two-week summer vacation is on the decline for today's travellers.

Outdoor recreation, natural, historical, and cultural resources are increasingly important attractions for travellers. Recreational and environmental tourism, as well as historic and cultural, can be relevant to greenway projects, which often link together cultural and natural resources, for example the Wye Marsh and Martyrs' Shrine.

Tourism is a significant component of the Severn Sound economy. The Georgian Lakelands area generated $415 million in income and employed 18,500 people in 1985 (MTR, 1985). In Midland alone, tourism generates $15-$17 million in annual retail sales (Midland Economic Strategy, 1991). The tourism component of the AOC's economy is expected to grow as approximately 2,600 condominium units are proposed from Penetanguishene to Victoria Harbour, and 2,600 additional boats slips are planned for the Severn Sound area (Keir, 1991).

The potential impact of the RAP on waterfront development and tourism in the area is best articulated by the Centre for the Great Lakes' recent report. "Centre research found that new development enhances property values and image of urban communities.... Keys to successful waterfront development include promoting public access and recreation,... linking waterfront renewal with economic development,... to make the waterfront a year-round amenity,... and restoring waterfront environments. The success of the region's waterfront development effort is inextricably linked to improvements in the water quality of the Great Lakes and St. Lawrence River, and poor environmental quality can be a barrier to development and use of the waterfront" (Centre, 1991). While no monetary estimate is easily obtained, the potential impact of the RAP on tourism in the Severn Sound area is likely substantial.

Infrastructure

The adoption of a comprehensive municipal water demand/conservation management program can have significant benefit for water-related infrastructure. Reductions in the use of water can result in sewage treatment plants working more efficiently (Patry and Takacs, 1990), and reduce energy requirements and the chemicals required to treat the water. In Collingwood for example, once the water conservation program is in 'full-swing', it is estimated that water and hydro savings combined will total about $100 per customer, as well as lower costs for pumping, filtering and treating the water (Collingwood RAP Socio Economic Fact Sheet). Also, the shift to the user pay concept and full-cost pricing will become more equitable for consumers (Fortin and Mitchell, 1990; Rawson, 1990). But one of water conservation's greatest potential benefits is the extension of the life of sewage and water treatment plants, or making expansion completely unnecessary (Patry and Takacs, 1990).

Detailed work on the economic impact of a comprehensive water conservation program for both Severn Sound municipalities and industry has not been undertaken; however, experience from other areas in Canada and the United States suggest that water conservation can result in considerable benefits through cost savings for infrastructure. However, included in some sewage plant upgrades projects in the Severn Sound area is the need for additional treatment capacity in order to treat all existing sewage flows and future development that conservation does not accommodate.

6. IMPLEMENTATION

The RAP Team has developed considerable background data and expertise in the area. There is an excellent rapport with the municipalities. The public expects "things to happen" and they are ready to participate. The Public Advisory Committee has considered RAP implementation in depth. The PAC concluded that the following elements are necessary to implement the Severn Sound RAP:

1. A full time RAP Implementation Coordinator to continue to coordinate RAP activities and to provide the vital link between the public and the government agencies supporting the RAP.

2. A RAP presence in the community in the form of a local office staffed to provide local information and coordination.

3. Working groups composed of government representatives and members of the public to oversee implementation of the remedial actions.

4. The PAC or Implementation Public Advisory Committee (IPAC) would by necessity be separate from the implementors in order to act independently in influencing decisions and assessing progress of implementation, additional information and project needs to obtain delisting standards.

The Federal/Provincial COA agencies through the RAP Steering Committee and/or the agencies represented would be expected to provide support for RAP Implementation as well as public involvement. The municipalities around the Severn Sound shoreline and in the immediate watersheds are also viewed as key stakeholders and implementors to the process.

6.1 Priorities for Action and Implementation Schedule

The RAP Team has taken every opportunity through the development of the RAP to start implementation where possible. Examples include:

- Interim Phosphorus Control Strategy for Penetanguishene Bay and the Town of Penetanguishene sewage treatment plant upgrades
- Assisting in the review of Elmvale Sewage
- Assessing enhanced phosphorus removal technology for sewage plants
- Supporting the demonstration of no-till drill for reducing soil erosion
- Arranging funding support for a Pollution Control Survey of Severn Sound shoreline development
- Rehabilitating tributary stream habitat by arranging funding of a project operated by MNR with local partnerships
- Establishing the Severn Sound area as a Clean Up Rural Beaches (CURB) watershed for implementation. This has involved setting up a local CURB Steering Committee for the review of projects to control sources of phosphorus and bacteria such as manure storage and barnyard runoff, milkhouse waste, cattle access and rural septic systems.
- Several commitments from municipalities such as incorporating RAP concerns in official plan revisions.

The vision is to restore environmental quality and to ensure continued protection through implementing a legacy of wise stewardship of Severn Sound and its tributaries for the future.

The response to the Severn Sound Remedial Options Discussion Paper from the Public Advisory Committee (April, 1991) indicated that the public is interested in seeing virtually all of the options implemented. A concerted effort on the part of all stakeholders in the area will be required to restore quality and beneficial uses of Severn Sound. The recommended actions for phosphorus control, reviewed in Section 4, were examined to lay out a 5-year horizon of implementation (Table 6.1). The scenario shown gives known schedules for some actions and an estimate of the time required for those actions which are not presently planned. The schedule shows that within 5 years it is possible to complete most of the actions that would meet the RAP targets given cooperation of all parties concerned within the time frame outlined. Research into treatment technology, especially for achieving RAP goals at reduced cost, will continue beyond the 5 year period.

The research into fish and wildlife habitat is expected to be completed by 1995. Plans to incorporate RAP goals and actions should be completed within the five year horizon; however, implementation through better development planning and controls will continue, dependent on development demands and requiring regular tracking and periodic assessment.

A proposed "fast track" scenario of RAP implementation based on estimated time required for approvals, design and construction, suggests that five years would be required for implementation to take place (Table 6.1). This estimate does not take into account funding arrangements or the effect of technology innovation or changes in treatment requirements expected (especially for eg. storm water treatment). The specific actions, responsibilities, schedule and funding for each remedial action will be confirmed during the implementation phase. Agreements and/or positions of government agencies, municipalities and other key stakeholder groups will be developed and reported annually along with progress on meeting delisting objectives, surveillance and monitoring reports and assessments of remedial actions.

Implementation will also involve specific responsibilities of stakeholders including government agencies, municipalities, the farming community and conservation groups. These responsibilities are indicated in Table 6.2

Table 6.1: 5 YEAR HORIZON FOR RAP IMPLEMENTATION
PHOSPHORUS CONTROL STRATEGY

1. IMPROVE SEWAGE PLANT EFFICIENCY
(note: fast track scenario to achieve interim effluent requirements at forecast design flows)

	1992/93	1993/94	1994/95	1995/96	1996/97
Penetang -Main St.	- Final design and approvals	- Construction $3.0M	- Construction $2.0M	- 1st year operation at <0.15 mgP/L	
Elmvale	- Interim Treatment - EA Process - Preliminary design and approvals	- Final Design and approvals - Construction $3.0 K	- Construction $2.5 K	- 1st year operation at <0.15 mgP/L	
Midland	- Optimization study	- Final Study - EA process - Design and approvals	- Final design and approvals - Construction $600K	- 1st year operation at 0.30 mgP/L	
Penetang - Fox	- Complete tertiary treatment evaluation - Design and approvals	- Construction $600K	- 1st year operation at <0.15 mgP/L		
Coldwater	- EA process	- Design and approvals	- Construction ???K	- 1st year operation at 0.3 mgP/L	
Port McNicoll	- Currently meets interim at 0.3 mgP/L	- Optimization study? for expansion?	- EA process - Design and approvals	- Design and approvals	- Construction ???K
Victoria Harbour	- Currently meets interim at <0.15 mgP/L	- "stress testing" of sand filters for performance	- Modification for performance at higher flows	- Continues to meet <0.15 mgP/L	

2. UPGRADE PRIVATE SYSTEMS

	1992/93	1993/94	1994/95	1995/96	1996/97
Pollution survey - shoreline	Year 3 - 500 inspections - abatement	Year 4 - abatement	- case by case	- case by case	- case by case

Table 6.1: 5 YEAR HORIZON FOR RAP IMPLEMENTATION PHOSPHORUS CONTROL STRATEGY

3. REDUCE URBAN STORMWATER LOAD (note: Most existing bypass problems included in sewage plant upgrades)					
	1992/93	1993/94	1994/95	1995/96	1996/97
Existing sources	- CSO/Bypassing - Midland design	- Upgrade pumping stations Midland $1.0M	- 99% decrease in bypassing in Midland		
Mini Pollution Control Plant (Midland/Penetang)	- Study	- Study	- Demo projects		
Management plans		- Study	- Plan reviews		
4. REDUCE AGRICULTURAL SOURCES					
	1992/93	1993/94	1994/95	1995/96	1996/97
Tributary rehabilitation project	Year 2 Projects $100K	Year 3 Projects $100K	Year 4? Projects $100K		
CURB, Rural source control	Year 1 Projects - $75K Demos - $50K	Year 2 Projects - $75K Demos - $50K	Year 3 Projects - $75K	Year 4 Projects - $75K	Year 5 Projects - $75K
TOTAL COSTS	$2.25M	$7.85M	$3.27M	$75K	$75K

Note: Costs are for capital construction. Costs for study and administration not included.

Table 6.2: Severn Sound RAP
Implementation Responsibilities and Priorities

Remedial Action	Priority	Responsibility (lead agency in bold)
1. SEWAGE PLANTS		
a. optimization	#1	**Municipality**, MOEE, Env. Can.
b. upgrades	#1	**Munic.**, MOEE, Env. Can. (technology)
c. outfalls	#2	**Munic.**, MOEE, Env. Can. (technology)
d. consolidate	#3	**Munic.**, MOEE, Env. Can. (technology)
e. sludge storage	#2	**Munic.**, MOEE, Contractors
2. PRIVATE SEWAGE		
a. replace	#1	**Shoreland owner**, MOEE, District Health Unit
b. removal efficiency	#3	**MOEE**
3. STORMWATER		
a. bypass/CSOs	#1	**Munic.**, MOEE
b. urban stormwater	#2	**Munic.**, MOEE, MNR, Env. Can. (technology)
c. retention/treatment	#2	**Munic.**, MOEE, MNR
d. clearing of land	#1	**Munic.**, MNR
e. master plan	#3	**Munic.**, MOEE, MNR
4. AGRICULTURE		
a. manure storage	#1	**Landowner**, MOEE, OMAF
b. manure spreading	#2	**Landowner**, MOEE, OMAF, Munic.
c. sludge spreading	#2	**Landowner**, MOEE, Contractors, Health Unit
d. septage spreading	#2	**Landowner**, MOEE, Contractors, Health Unit
5. EROSION		
a. stabilize banks	#1	**MNR**, Landowners
b. road construction	#1	**MTO**, Munic., MNR, MOEE
c. clearing of land	#1	**Munic.**, MOEE, MNR
6. MARINE		
a. enforce black water legislation	#1	**MOEE**
b. encourage grey water storage	#2	**MOEE**
c. lead agency for review	#2	**MNR**, DFO, Transp. Can., Munic.
d. review to include FHMP	#1	**MNR**, DFO, Munic.
e. stabilize coast	#2	**MNR**, DFO

Remedial Action	Priority	Responsibility (lead agency in bold)
7. FISH & WILDLIFE POPULATIONS		
a. preserve wetlands	#1	**MNR**, DFO, Conservation Groups, Munic.,
b. create coastal habitat	#2	**MNR**, DFO, Munic. or "Landowner"
c. FHMP	#1	**MNR**, DFO, Munic.
d. rehabilitate tributary habitat	#1	**Landowner**, MNR, MOEE, Env. Can.
e. stock walleye	#1	**Conservation Groups**, MNR
8. CONTAMINATION		
a. implement MISA	#3	**MOEE**, Munic.
b. conserve water	#2	**Munic.**, MNR, MOEE, Env. Can.
c. alternative P-free products	#1	**Landowner**, MOEE, Env. Can. (Info)
d. phase out products with contaminants	#1	**MOEE**, Env. Can.
e. control bacteria	#2	see Actions 3. and 4.
f. monitor for sources	#1	**MOEE**
9. INPUT & REVIEW		
a. model OPA	#2	**Munic.**, MMA, MOEE
b. Storm Management Plans	#2	**Munic.**, MNR, MOEE
c. farm plans	#3	**Landowner**, NSSCIA, OMAF
d. FHMP review	#1	**MNR**, Munic.

Note: Priority #1 = those actions for which implementation is clear and can proceed.
Priority #2 = those actions that will be preceded by short-term study of technology and/or cost.
Priority #3 = those actions identified as requiring longer-term study to understand cause and effect of remediation and additional consultation prior to implementation.

6.2 RAP Implementation Structure

An implementation structure must be established (Figure 6.1) in order to achieve RAP implementation in an efficient and coordinated manner,). The following sections describe the role and membership of committees and work groups that will implement the Severn Sound RAP.

6.2.1 RAP Implementation Committee

The Implementation Committee (IC) will represent the agencies and municipalities with direct responsibility to implement the remedial actions and will:

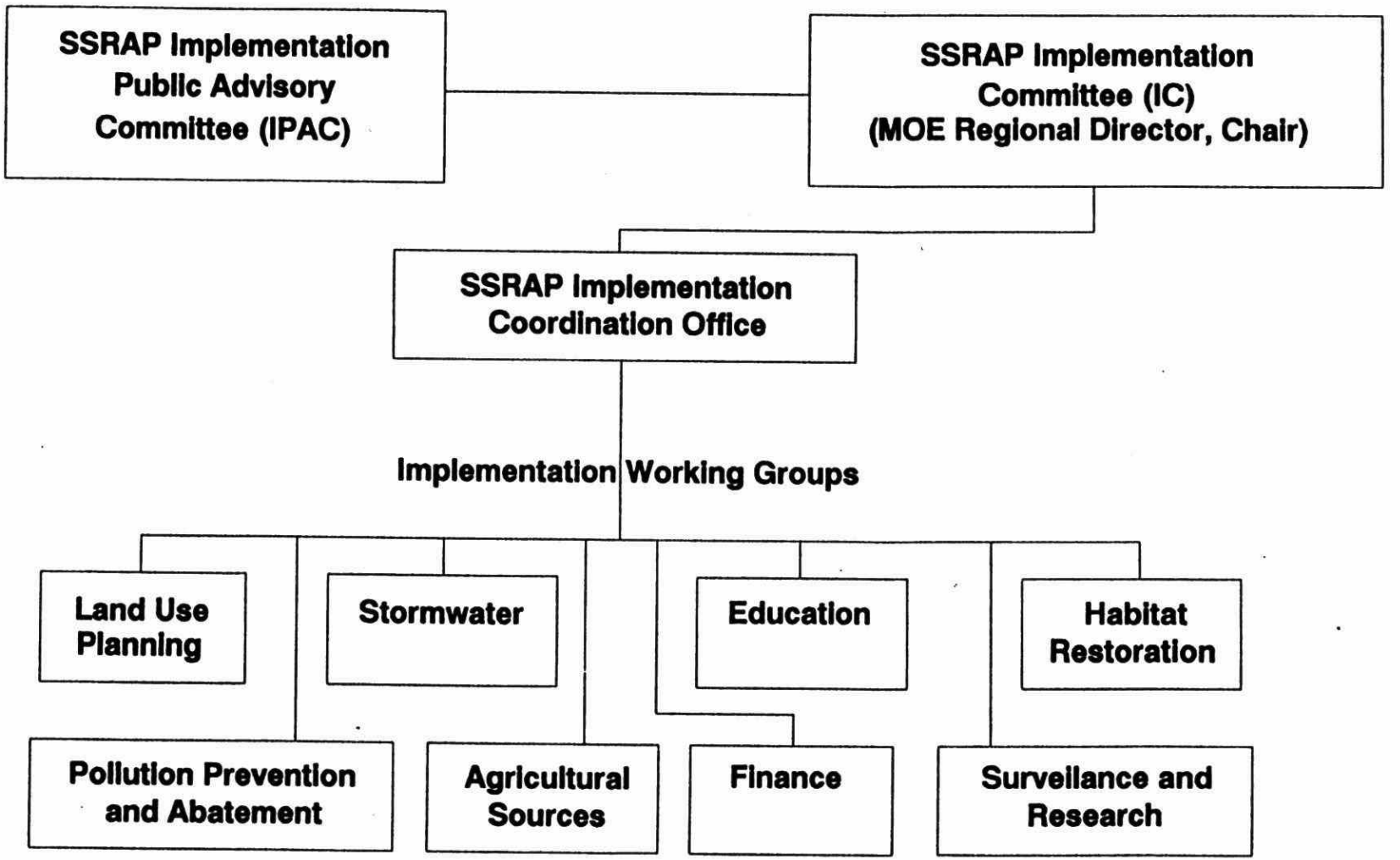
- Coordinate programs to address RAP recommendations
- Facilitate implementation agreements and funding for remedial actions
- Report on progress of work groups, including annual reporting on:
  - -implementation of remedial actions
  - -restoration of beneficial uses
  - -environmental conditions of Severn Sound
- Conduct regular (quarterly) formal, Heads-of-Council meetings to inform all the Severn Sound area municipalities on RAP progress and to provide a forum for discussion of implementation issues affecting their municipalities.

Membership on the IC will include:

- Regional Director, MOEE Central Region or his/her designate as chair
- The Severn Sound RAP Implementation Coordinator
- Environment Canada Representative
- MOEE Water Resources Branch Representative
- MNR Representative
- OMAF Representative
- Ministry of Municipal Affairs Representative
- Municipal Representatives - to be arranged (maximum of 4)
- Medical Officers of Health or their designates
- Department of Fisheries and Oceans Representative
- SSRAP IPAC Representative

Figure 6.1

The Severn Sound Remedial Action Plan
Implementation Structure



6.2.2 Severn Sound RAP Implementation Coordination Office

An office will be set up in order to coordinate RAP Implementation in the area and to ensure a continued RAP presence in the community. The office will:

- house implementation project staff (eg. RAP data coordinator, RAP Staff, CURB staff, Tributary Rehabilitation Project staff)
- act as a centre for references and databases on Severn Sound used in assessing the remedial actions and completing the implementation projects
- provide educational and information pamphlets and materials for the public
- provide secretarial support for RAP meetings and reports
- provide financial accounting of the RAP implementation projects

The Severn Sound RAP Implementation Coordinator would be a Ministry of the Environment and Energy Employee assigned to the Severn Sound RAP for a five year term. The RAP Team and the PAC have stressed repeatedly the importance of having a provincial agency employee act to coordinate the RAP implementation locally. Only with this dedicated resource in the area can the RAP implementation be achieved. The role of the implementation coordinator will be to:

- establish an Implementation Office and coordinate an ongoing public involvement and communications program with the Public Advisory Committee
- liaise among federal departments, provincial ministries, municipalities and private sector groups and individuals on issues related to RAP implementation
- facilitate development, submission and delivery of proposals for funding the Severn Sound RAP
- coordinate surveillance and monitoring activities for the RAP including the development of an annual work plan for tracking environmental conditions and the effectiveness of remedial actions
- complete RAP documentation required under Annex 2 of the Great Lakes Water Quality Agreement
- produce annual progress reports on RAP implementation for the Implementation Committee and as required by funding agencies
- prepare briefing materials for the Implementation Committee and for use by provincial and federal agencies

6.2.3 Severn Sound RAP Implementation Public Advisory Committee (RIPAC)

The role of the RIPAC includes:

- auditing the RAP implementation - reviewing progress, funding arrangements, recommending changes to the RAP
- providing annual public advisory committee reports on implementation progress
- reviewing and contributing to the general report with the IC
- participating directly in the public awareness and education of the RAP Implementation, environmental conditions and remedial actions in cooperation with the Implementation Committee
- assisting with fundraising for implementation projects
- reviewing data to provide direction to new and ongoing projects

Membership on the RIPAC would include: concerned citizens, representatives of agricultural groups, ratepayers association representatives, representatives of conservation groups, boating and sailing clubs. The Chair of the RIPAC could sit on the IC. Other members may wish to serve on work groups responsible for implementation of specific actions (see below).

6.2.4 Severn Sound RAP Implementation Work Groups

The following work groups will be formed to facilitate implementation of each area of the RAP. Responsibilities proposed are included under each title. The work groups would be formed of appropriate agency representatives and members of the IPAC.

1. Land Use Planning
    - . develop and gain approval for model Official Plan Amendment
    - . other planning issues
        - storm water
        - capacity
        - farm plans

2. Pollution Prevention and Abatement
    - . engineering and receiving water requirements for sewage treatment plants
    - . treatment technology assessment plant optimization
    - . treatment methods for sewage plants
    - . assessing private sewage systems
    - . facilitate implementation of MISA municipal program

3. Stormwater
    - . developing storm water management plans with municipalities
    - . assessing best management practices
    - . facilitating storm water treatment projects

4. Agricultural Sources
    . includes formal CURB Steering Committee
    . provide guidance to Tributary Rehabilitation Program

5. Finance
    . arrange funding for RAP implementation projects
    . develop partnerships

6. Education
    . facilitate the transfer of RAP information and technical reports

7. Surveillance and Research
    . coordinate monitoring plan activities
    . progress reports for the IC

8. Habitat Restoration
    . Fish Habitat Monitoring Plan implementation, monitoring and update
    . work toward one-window marine construction proposal review
    . specific habitat rehabilitation projects (ie. Penetanguishene Shoreline Project)

6.2.5 Progress Reporting Mechanisms

The following reports would be coordinated by the Implementation Coordination Office for the IC.

. Annual Implementation Progress Report
. Annual Implementation Advisory Committee Report? or combine it with Progress Report
. Annual Reports of each Work Group

7. PUBLIC CONSULTATION

The public plays a crucial role in the development of RAPs. People's opinions must be integrated with agency goals in every phase of the plan development to ensure that a broad public consensus is reached. Both the government of Canada and the government of Ontario are committed to an extensive public involvement program (PIP) during the development of RAPs as stated in the 1987 Protocol of the Great Lakes Water Quality Agreement (IJC, 1988). The public or "stakeholder" is any person, group or organization with an interest or stake in the water quality or water use of the area of concern. In Severn Sound, the PIP is aimed at target groups that include:

- agriculture, industry and commerce related groups
- environmental, public interest and community groups
- federal and provincial agencies
- local media
- municipal governments
- private citizens
- ratepayers'/cottagers' associations
- sports, fishing and tourism groups

7.1 The Phases of Public Consultation

Public Consultation of the Severn Sound RAP has been divided into four phases:

Phase I (complete)	inform and educate the public about the RAP process, the existing environmental conditions in Severn Sound, and identify interested stakeholders.
Phase II (complete)	obtain the public's views on desired water uses and goals for Severn Sound.
Phase III (complete)	obtain public input and feedback on proposed remedial actions, and then cost/benefit for achieving the identified water use goals.
Phase IV (1993)	obtain public feedback on the draft Remedial Action Plan report for Severn Sound.

Phase I - Informing the Public

To help people develop an awareness and understanding of the Severn Sound RAP process and the environmental conditions of the Sound, a communications plan was developed. In 1988, the Severn Sound RAP Team retained a consultant to develop a mailing list of key stakeholders with a known or potential interest in water quality issues in the Severn Sound. They represented diverse groups and individuals in the area. As a result of the preliminary research over a period of several months, approximately 330 names were listed. The list has grown to over 830 names since 1989.

Information and education activities were aimed at recognized stakeholders and also at the general population of Severn Sound whenever possible. These included public meetings, workshops, the dissemination of newsletters, questionnaires, fact sheets, posters, media releases, as well as the presenting of slide shows, public displays and presentations to groups on request.

The creation of a Public Advisory Committee (PAC) in February of 1989 marked a focal point for public consultation where ideas could be exchanged between the RAP Team and the general public. The PAC is a blend of opinions and expertise. Membership includes a diversity of private citizens and representatives of the public sector and the government. The RAP Team Coordinator attends all of the meetings which are open to the public. At present, PAC individuals represent the following:

- Citizen, Coldwater
- Citizen, Penetanguishene
- Citizen, Waubaushene
- Cognashene Cottagers' Association
- Georgian Bay Association
- Georgian Bay Islands National Park
- Midland Public Utilities Commission
- North Simcoe Soil and Crop Improvement Association
- Orr Lake Ratepayers' Association
- Robin's Point Ratepayers' Association
- Sierra Club
- Town of Midland
- Town of Penetanguishene
- Township of Georgian Bay
- Township of Matchedash
- Township of Tay
- Township of Tiny
- Trees for Today and Tomorrow
- Trout Unlimited
- Victoria Harbour Ratepayers' Association
- Wye Marsh Wildlife Centre

Although the PAC can assume very different roles during different phases of the RAP, it has acted as an advisor, watchdog and communicator. Initially, PAC meetings provided an educational forum for the discussion and exchange of technical information. As the information phase progressed, the PAC moved on to consider use goals and the implications these would have on remediation.

PAC's involvement in the development of the RAP has not been limited to merely defining and approving water uses and remedial options. The determination of members to prevent the Sound's water quality from worsening has led to a number of tangible results that have answered the common public outcry for action now, not later! These "short-term remedial actions" help to maintain RAP momentum and public support (Hartig et al., 1992). For instance, a survey of all shoreline private sewage systems was prompted by the PAC and the committee's correspondence with the Township of Georgian Bay resulted in the passage of a grey water bylaw, the first grey water legislation in Ontario. As well, the PAC has continued to provide advise and/or support for such projects as local development proposals, phosphorus control strategies, official plans and policies.

Phase II - Establishing Water Use Goals

The first step in developing the RAP was to establish goals for the future use of Severn Sound based on public aspirations and concerns. Questionnaires to stakeholders, public meetings and PAC discussions helped to determine the community vision. Follow-up reports of the public consultation effort were sent to all stakeholders and PAC members. They included a summary of the public meetings, the concerns and particular interests that were raised and future plans of the RAP. Building a consensus during phase II not only helped to define use goals, it also helped to maintain public awareness of the RAP process (Severn Sound RAP, 1990).

Phase III

Public input was needed to build a consensus. The remedial options to improve water quality, based on the water use goals decided earlier, had to be reviewed and prioritized. The RAP Team with the help of the PAC prepared the Remedial Options Discussion Paper (RODP) (Severn Sound RAP, 1990). More than 1,000 copies were mailed to individuals including the list of 712 stakeholders. They were also placed among the Severn Sound RAP reports, newsletters, brochures and other information brought to events and displays. PAC members presented the options to over 20 groups including ratepayers' associations, conservation clubs and municipalities. Also, public meetings were held in the fall 1990 to discuss the RODP and to record comments and questions. Notes taken at these meetings and the presentations as well as the short written replies, briefs and response sheets that were received all comprise the feedback that was necessary to determine the preferred remedial options.

Based on the public responses to the RODP and all of the relevant technical information, the PAC had to indicate their support for each option. The results of their discussions are summarized in the Severn Sound PAC Position and Public Response to the RODP (Severn Sound PAC, 1991).

Phase IV - Public Review of RAP Stage 2

The Draft Stage 2 Document has included the recommendations identified in all phases of the PIP. During phase IV, the public will be given an opportunity to review the draft RAP. A Municipal workshop and a meeting of Municipal Heads of Council have been held to garner local support and to discuss portions of the Stage 2 and the roles municipalities will take during implementation of the options. Future events include:

- release of Stage 2
- review and communication of Stage 2 by PAC, RAP Team and key stakeholders
- public meeting to complete the review of Stage 2

Public involvement will continue during the implementation of the remedial action plans to:

1. maintain public interest in and awareness of local water quality issues
2. provide a continuing basis for broad community support for RAP implementation
3. ensure that the RAP remains a continuous priority for the implementors
4. monitor implementation of remedial actions and track progress under the plan, and
5. support the development of a consensus on revisions or modifications to a RAP.

(COA RAP Steering Committee, 1990)

PAC members are already discussing roles the committee will play in the future such as encouraging and directing public involvement, monitoring and auditing implementation plans and coordinating education, communication and fund-raising. They have also been considering an implementation plan for the Severn Sound RAP based on the models of other RAPs.

7.2 Measures of Effectiveness

Public consultation should provide opportunities for many different stakeholders to involve themselves in the decision-making process from beginning to end. Targets, timing and techniques of the public involvement process are all important.

Severn Sound is a relatively large area of concern covering 1000 km^2. There are 15 Municipalities with an estimated 60,000 permanent residents and 40,000 seasonal residents within the area. To reach as many people as possible, newsletters, documents and other information have been sent to people on the mailing list and to the general public as household bulk mail. Over 830 stakeholders and 18,600 homes have received the latest newsletter.

In addition to mailings, reading materials, displays and posters have been located at many events throughout the Severn Sound and at general stores, marinas, restaurants and malls. As a result of these efforts, new people are continually expressing an interest in the program

and a willingness to be involved in some way. The Severn Sound RAP PIP has succeed in reaching a wide segment of the population.

In Severn Sound, however, the needs of stakeholders are just as important as total numbers. The unique characteristics of a population have to be considered. Because they represent a significant portion of the population, certain stakeholders' groups have been singled out for public consultation activities. Boaters and marina operators were identified as key players early in the PIP. A Marine Practice Workshop was held in February '89 to promote environmental awareness and a RAP Team report on the workshop was inserted in the Wye Heritage Marina newsletter sent to over 1500 people. Special meetings with the agricultural community have been held to discuss ways of reducing phosphorus export from farms.

The large number of municipalities within the Severn Sound watershed called for special communications efforts to facilitate understanding and dialogue between local governments and the RAP Team. These included municipal workshops and personal invitations to municipal officials and representatives to attend PAC meetings. Another example of a directed public involvement approach was the initiative taken by PAC members to present the remedial options to their affiliated interest groups.

Frequency of informing the public has been kept high. A newsletter was distributed regularly to report on current RAP research and events. Meetings, mailings, presentations and media releases have preceded the release of the discussion documents and other major events in every phase of the RAP. As well, the distribution of materials upon request and their prominent placement at local events, libraries, post offices and municipal buildings is part of a continuing phase of informing the public. Fluctuations in the population of Severn Sound throughout the year have influenced the timing of the PIP. In rural townships, seasonal populations outnumber permanent residents by greater than a 2:1 ratio (Kier 1991). To involve both permanent and seasonal residents, major public events were held from the late spring to early fall.

Opportunities for groups and individuals to comment on the information they receive have been available in every phase of consultation. "We want your input!" has been the familiar phrase. Response sheets included in documents and questionnaires to specific interest groups have been the common means of obtaining feedback. PAC meetings are held monthly and members have committed approximately 1,845 person hours since their first gathering in February '89. Letters of invitation and regular advertisements to more than 25 media outlets encourage citizens to join the PAC.

For meaningful consultation, a variety of approaches to involve the public have been taken. Large public meetings have been a popular means of soliciting information with discussion during many RAP consultation programs. Less common approaches, however, were also taken during the Severn Sound RAP PIP such as workshops with community groups, questionnaires about water quality goals and meetings with key interest groups (Landre et al. 1990) (Table 6.1). A RAP/PAC tree planting competition and DO Day, an event held

to measure bottom water levels of dissolved oxygen (DO) and to allow the public to observe information displays and to meet with the RAP Team, were more unusual departures from display/lecture techniques to involve the public (Appendix 6.1).

People have been actively involved in the process of consultation especially during dialogue and consensus building. Representatives of agencies, conservation groups and municipal planners contributed much of their time and expertise to the creation of the Fish Habitat Management Plan for Severn Sound (Severn Sound RAP, 1992). The regular attendance of committed people at PAC meetings once a month, the help of children's clubs, school groups, conservation groups, agencies, the PAC and RAP team and other individuals during projects such as tree planting, are other examples of an active PIP.

A PIP should be flexible so that it may adapt to unforseen situations and respond to people's needs and opinions. Certain circumstances were recognized as opportune moments to involve the public. RAP scientists joined Ontario Ministry of Natural Resources biologists conducting a summer creel survey to ask the anglers their opinions regarding water uses and water quality. They also modified a fact sheet that recommended the use of herbicides as one option to control water weeds because of the concerns expressed by the PAC (Bourrie, 1989).

The success of public consultation can also be reflected in the media. While the publicity of the Severn Sound RAP has been extensive, it hasn't always been positive. Not long after the RAP was launched, the press was quick to overdramatize boaters' concerns that they were being singled out as the main contributors of pollution as well as citizen opposition to the RAP fact sheet recommending the use of registered herbicide to control aquatic weeds (Desroches, 1991). Since then, reporting has been more favourable. Some of the more flattering headlines and quotations are: "RAPs voice is worth listening to" (Midland Free Press, June 1990), "our customers can only benefit from the RAP" (Marina News, July-Aug 1989) and "it (the Severn Sound RAP) is a refreshing change from past government programs" (Tyndale, 1989).

The popularity of the Severn Sound RAP exemplified by community groups and individuals who have pledged their support, requested advice and expertise and adopted RAP objectives, also suggests the PIP has succeeded in communicating RAP goals. RAP objectives have been adopted by the Township of Tay directly into their Official Plans and by a local ratepayers' association which has designed a remedial action plan for their area.

Coordinators in a majority of the AOCs reported that the extent of public involvement, especially at the local level, separates RAPs from previous attempts by agencies to consult the public (Landre et al., 1990). Everyone concerned about the future of their watershed community will want to be involved in restoration projects, planning and monitoring progress. The Severn Sound RAP public involvement program has attempted to provide the information and opportunities the community will need to meet these challenges. Tributary rehabilitation activities have raised the profile of Severn Sound RAP with individual

landowners and have helped people understand the roles each individual in the watershed can play from tree planting to land retirement and environmental farm planning.

TABLE 7.1: PUBLIC CONSULTATION ACTIVITIES OF THE SEVERN SOUND RAP				
Activity	Information Out	Public Comment (Information In)	Dialogue with Consensus Building	Follow-up
Description	Government actively disseminates or provides access to relevant information to public to inform and provide the basis for constructive input.	public responds to issues/proposals/ information.	Public and government engage in dialogue to clarify issues/perspectives and to work toward consensus	Government responds to input received and communicates with public about outcome and decisions.
Examples of Severn Sound RAP public consultation activities	o mailings o handouts o media o announcements o press releases o posted notices o site visits o information meetings	o response sheets o record of questions and answers o questionnaires	o PAC o workshops o public meetings	o mailings o handouts o media o announcements o press releases o posted notices o information meetings

Source: MOE Task Force on Public Consultation, 1986

8. SURVEILLANCE

A well defined surveillance plan is a requirement of a complete remedial action plan. Monitoring of the restoration of Severn Sound will be necessary in order to indicate when restoration objectives have been reached. Once these objectives are achieved, delisting of Severn Sound as an Area of Concern can proceed. Moreover, monitoring and research on the effectiveness of remedial actions is also necessary to ensure efficient restoration.

The purposes of the surveillance plan for Severn Sound are to:

1. coordinate activities for effective and efficient monitoring
2. assess the effectiveness of remedial actions in restoring impaired uses
3. indicate when restoration objectives have been met

The problems identified for Severn Sound in the Environmental Conditions and Problem Definition Report (Stage 1) and in the International Joint Commission review included the following:

1. Widespread degrees of eutrophication as evidenced by excessive algal growth in Severn Sound, particularly in Penetanguishene Bay.
2. Loss of habitat and degraded fish populations.

The correction of these problems and the achievement of Severn Sound use goals can be broken down into five functional areas for monitoring purposes:

1. Eutrophication
2. Fish and Wildlife Habitat
3. Ecosystem Health
4. Bacterial Contamination
5. Trace Contaminants

The following discussion provides the rationale for specific monitoring activities in the Severn Sound area (Figure 7.1).

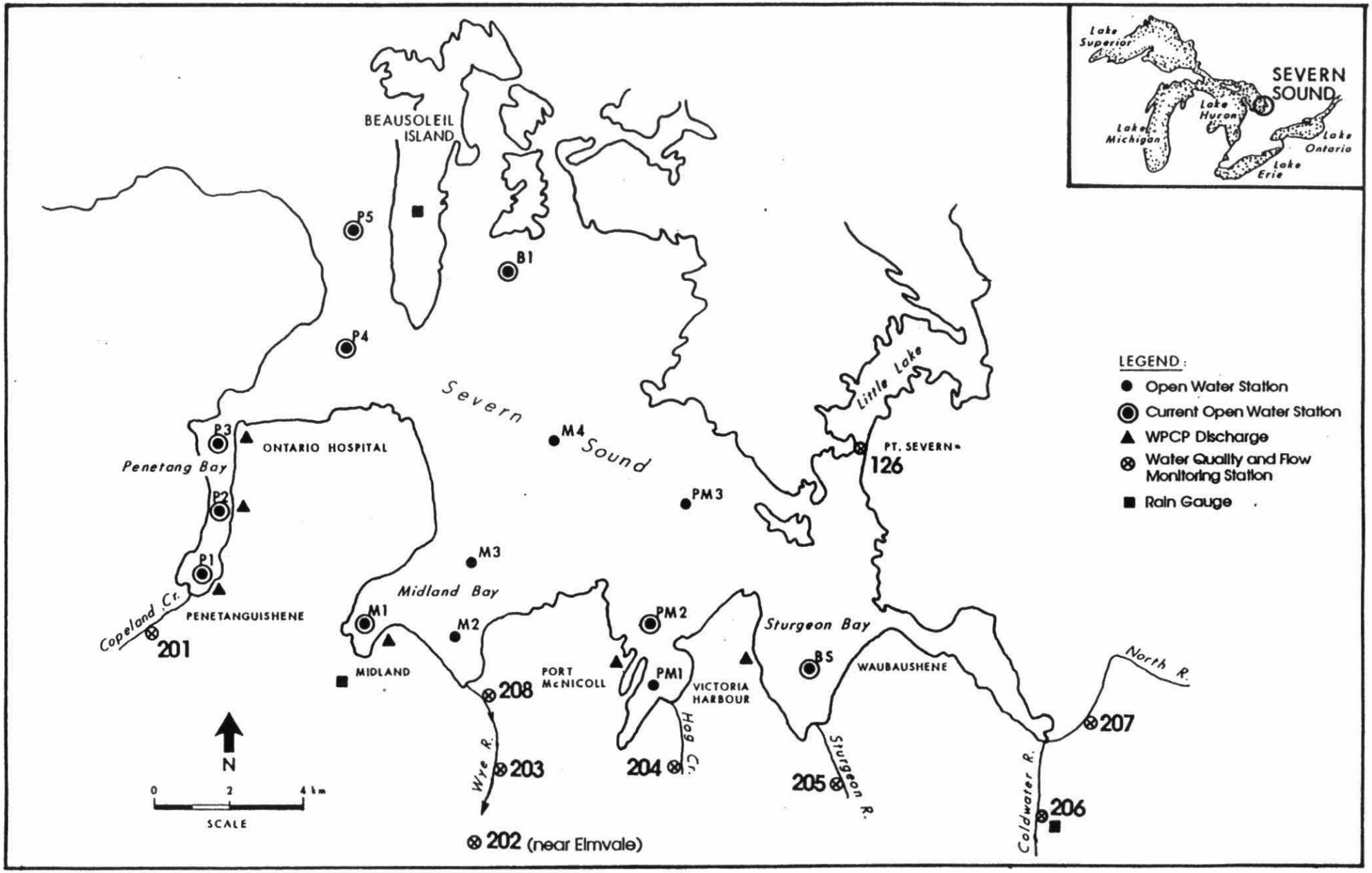


FIGURE 8.1 Water Quality and Flow Monitoring Stations in the Severn Sound area

8.1 Eutrophication

Assessment of the trophic status of Severn Sound will be especially important over the next five to ten years as remedial actions to reduce phosphorus sources and improve aquatic community balance are implemented and take effect.

Activities to monitor reduction of eutrophication in the Sound include:

1. Open water monitoring of nutrients, dissolved oxygen, community structure and key populations of phytoplankton (suspended algae) and zooplankton (algae eaters). This will be carried out each year at the routine open water stations on a biweekly basis throughout the ice free period of the year (May 1-September 30).
2. Monitoring of nutrient (especially phosphorus) sources including sewage plant effluents, tributaries and other sources.
3. Assessment of the benthic community structure and key indicators.

8.2 Fish and Wildlife Habitat

In several areas of Severn Sound, particularly in Penetanguishene and Midland Bays, gain in fish habitat is expected following the development of areas of severely degraded nearshore habitat. Fish habitat in the nearshore areas of Severn Sound has been classified on an interim basis with respect to susceptibility to damage from shoreline development activities (Severn Sound RAP, 1992). Twelve kilometres of shoreline (4% of total shoreline) have been identified as areas for habitat creation. It will be necessary to monitor the work permits and shoreline activities, on an ongoing basis, in order to prevent inappropriate shoreline alteration and destruction of habitat. It is also important to develop an approval process for projects in Penetanguishene Bay.

Surveys of fish habitat are continuing in order to document the capacity of Severn Sound to sustain a productive and naturally reproducing fish community. These studies will improve on the existing classification of nearshore habitat and the fish community monitoring techniques.

8.3 Ecosystem Health

Monitoring the health of the complex ecosystem of Severn Sound can appear a daunting task. There are some monitoring activities that have been identified as important "first alert" indicators such as birth defects in double crested cormorants. Some identified problems also require specific monitoring to document response to rehabilitation efforts; e.g. the health of the walleye population. There are both natural and human factors that cause populations and communities to change. The surveillance plan for the RAP must focus on the human

influences in the context of the natural changes. For example, a healthy, self-sustaining colony of double crested cormorants may be devastated by a natural disease which is transmitted to the colony by other birds rather that through some pollution source. The knowledge base of techniques and indicators of ecosystem health are constantly being improved in the scientific and environmental management literature. New indicators and monitoring methods of ecosystem health are expected from ongoing studies of fish, benthos, waterfowl and other organisms in Severn Sound and other areas of the Great Lakes. Results of these studies will add to the tools for assessment that in turn will guide and/or confirm remediation efforts.

Fish

Monitoring of the Severn Sound fish community must continue on an ongoing basis to track trends in population changes and community composition in response to remedial actions. In particular the restoration of top-level predators must be monitored.

Studies of the walleye population in Severn Sound are required as the population does not appear to be responding as yet to stocking efforts. Fisheries biologists must test theories that explain the walleye population changes in relation to other community changes (e.g. black crappie, brown bullhead increases, zooplankton size shifts). Routine index netting to maintain and improve on time trends in fish community structure must be continued.

Colonial Waterbirds

Many of these birds depend directly on the healthy, uncontaminated fish resources of Severn Sound for their food supply and as such provide a useful indicator of ecosystem health. Severn Sound has a diverse and self sustaining community of colonial waterbirds. An annual survey of Cormorant deformities at the North and South Watcher Island colonies, just outside Severn Sound will monitor the health of this sensitive indicator species.

Other Wildlife (including waterfowl)

Methods are being developed as part of the Matchedash Bay Project to monitor waterfowl changes in response to wetland habitat restoration.

Surveying and monitoring individual species will continue in order to establish environmental requirements, stress indicators and specific monitoring methods. The species considered include: map turtles, trumpeter swans and osprey.

8.4 Bacterial Contamination

Criteria of suitability of water for swimming and other water contact sports have been developed (MOE, 1984; MOH, 1992) in order to provide areas free of aesthetic problems related to floating debris and algal formations. In general, the waters should:

- have sufficient water clarity to allow a swimmer in distress to be seen on the bottom;
- have a low risk of contact with pathogenic organisms or health hazard.
- not be influenced by sources of bacterial contamination.

An important water use goal of the RAP is to be able to swim virtually anywhere in Severn Sound. Presently, sheltered bays around Beausoleil Island including Lost Bay, Frying Pan Bay and Ojibway Bays are considered health hazards due to elevated indicator bacteria. Algae scums and poor aquatic visibility affect the safety of swimmers and the aesthetics of Penetanguishene Bay and Midland Bay swimming areas with occasional aesthetic problems in other swimming areas. Improvements in the quality of the Sound following phosphorus control actions are expected to remove the aesthetic and safety constraints. However, small bays in Beausoleil Island will continue to be impaired due to pleasure boats using the embayments unless the contamination source is consistently controlled.

Monitoring of public bathing beaches should be carried out by Health Units, Municipalities or Operating Federal or Provincial agencies according to the MOH Beach Management Protocol (MOH, 1992). Beach Pollution Surveys should include monitoring of source discharges in built up areas on the south shore and boat anchorages in sheltered isolated embayments on the North shore.

8.5 Trace Contaminants

Extensive assessment of potential sources of trace contaminants through biomonitoring and sediment contaminant assessment has been carried out as part of the RAP development in Severn Sound (Severn Sound RAP, 1988). These studies confirmed that Severn Sound is relatively free of active sources of persistent contaminants. Monitoring activity will therefore focus on screening for undetected sources and tracking trends in contaminant levels of the organisms that will most readily bioaccumulate contaminants and indicate their presence.

Localized fish, the young-of-the-year spottail shiners, have been collected and analysis indicates that little or no active sources of mercury or persistent organic chemicals such as polychlorinated biphenyls or dieldrin currently exist (Suns et al, 1991).

Persistent contaminants that have a direct bearing on consumption of fish and wildlife in Severn Sound included mercury and polychlorinated biphenyls. Other chemicals can have an influence on human health and aquatic life. Often, these substances will have elevated concentrations in discharges or in sediments that can serve to transfer the chemicals to

aquatic life. In Severn Sound, substances that have been investigated include: heavy metals (lead, zinc, cadmium, chromium, copper), organochlorine pesticides and their breakdown products, organotins associated with antifoulant paints and volatile organic chemicals.

Other substances, especially organic chemicals, could influence the health of the Severn Sound ecosystem which are not presently being tested. Tests of the health of specific organisms are the only indication of toxic substances in the absence of direct chemical measurements. For example, the incidence of liver tumours or reproductive failure/impairment in fish may be the first indication that an unknown chemical is affecting the environment.

Sediment samples from deposition areas of Severn Sound have also been assessed for metal content and organic chemicals for potential as sources to the water column and organic life (see section 2.3). An appropriate surveillance strategy would establish "sentinel tests" to screen sources for contaminants and to track the levels of chemicals in media known to concentrate the substance or in organisms known to register physiological responses to the presence of harmful chemicals. The continued use of Severn Sound as a reference site for biological effects testing would also facilitate continued surveillance. The following specific monitoring activities are recommended to track historical problems:

a. Contaminants in Waterfowl

Relatively low contaminant levels in colonial waterbird eggs confirm that the Severn Sound area is relatively free of contaminants. The community in and near Severn Sound includes self-sustaining populations of ring-billed and herring Gulls; common, black and caspian Terns; double crested cormorants; great blue herons; and other birds such as ospreys, Green-backed and black crowned night herons and bitterns. The incidence of deformities in Cormorant populations (a good indicator species) is presently low. Based on these indicators, the existing community (1990's) generally represents a healthy, diverse and self-sustaining community (Pers. Comm. C. Weseloh, CWS, 1992). Some information gaps require further research such as the reproductive success in Common Terns nesting in the Sound.

b. Sewage Plant Sludge

Sewage plant sludge is monitored to assess the quality of sludge for spreading on agricultural lands. In addition, the MISA municipal program recognizes sludge as an important media in screening assessments for toxic contaminant problems in municipal sewer systems. The result of the sludge quality analyses and any surveys of chemicals in use at area industries discharging to the sewers provides a useful "sentinel monitor" of contaminants that may pass through to the open water. The sewage plant sludge quality results will be reviewed annually as part of the Severn Sound RAP Surveillance Plan.

c. Mercury in Sport Fish

A sample of small and large mouth bass and northern pike will be collected on a 3-year frequency for mercury analysis. The protocol should be that of the MOEE/MNR fish contaminants program and include a minimum of 20 fish in a size range, sampled at the same location (Index Trapnet location) and time of year. The age of each fish sampled should be included with the sex, weight and length information typically collected. Walleye should be sampled in a similar fashion but on a reduced frequency (every 5 years) as the rehabilitated population allows.

d. Persistent Organic Chemicals in Carp

A sample of carp will be collected on a 3-year frequency for organochlorine pesticides and polychlorinated biphenyls. Similar to the Sport Fish Contaminant Program protocol, a minimum of 20 fish in a size range, sampled at the same location and time of year will be collected in order to track organochlorine chemicals and monitor residual concentrations noted in these fish.

e. Sediment Sampling

Replicate samples of each of the six deposition sediment monitoring areas will be collected and analyzed within two years of implementation of sewage plant upgrades.

8.6 Research Needs

The environment of Severn Sound can be protected effectively only if the cause and effects of pollution are understood. Research that will support accurate and efficient monitoring and surveillance as well as fill in additional gaps in our understanding of Severn Sound environmental conditions, includes the following areas:

1. Community Interactions

   Several interactions have been suggested by analysis of fish and zooplankton population trends. However, additional studies to test specific hypotheses are required.

2. Use of existing land-based locations for monitoring water quality

   Several land-based sites within Severn Sound could be used to set up long-term monitoring locations such as water intakes. A careful review of the existing quality data at these locations in comparison with open water and river stations should be carried out.

3. Testing of assumptions of nutrient modelling

   The assumptions for phosphorus modelling used in this document should be studied to test for errors and the effect of variability. Currents and water exchange should be investigated further within Severn Sound.

4. Partnerships between university researchers and agencies

   Cooperative agreements should be pursued with academic institutions to provide further investigations into the environment of Severn Sound and the effect of remedial actions for educational as well as research purposes.

5. Involving the Public in Environmental Monitoring

   Use of existing self-help programs to assist the public in the Severn Sound area with opportunities to organize monitoring programs for educational and surveillance purposes.

Table 8.1 outlines the specific monitoring activities and the agencies responsible. Many of these activities are already part of routine monitoring programs conducted in the area. Some of the activities will require special, occasional efforts by the agencies indicated and should be preceded with discussion and planning of survey design and sampling requirements.

Table 8.1: MONITORING SURVEILLANCE PLAN		
Environmental Problem/Concern	**Monitoring Activity**	**Responsibility**
1. Eutrophication	Bi-weekly sampling through the ice-free period at at least 9 locations.	MOE
	Sampling at municipal STP discharges and tributary flow on a weighted basis at index sites. Short-term monitoring of tributaries for effectiveness of rehabilitation in reducing erosion and local phosphorus load.	MOE/ Municipalities
2. Habitat Loss		
Fish and Wildlife Habitat	Keeping track of work permits and shoreline activities, especially near identified areas and shoreline in each category in order to prevent inappropriate shoreline alteration and destruction of habitat. Maintain "habitat budget" by area and overall on an ongoing basis. Document annual gains and losses. Include 5 year benchmark surveys.	MNR Municipalities IPAC
	Continued long-term monitoring of tributaries at existing stations for phosphorus load.	MOE
	Annual progress report of Matchedash Bay Project.	MNR/CWS
	Observations of fish community especially target species before and after stream rehabilitation. Monitor fish populations by establishing and sampling selected stations on all tributaries annually. Annual fish biomass and species composition estimates at index monitoring locations.	MNR/interest groups/developers/Municipalities/ government agencies
	Inform public of threats to nesting birds by human visitation during breeding season.	MNR/CWS
Dredging Activities	Review of all dredging proposals including disposal of dredged material to ensure that the Provincial Sediment Quality Guidelines are being met.	MNR/MOE/ applicant

Table 8.1: MONITORING SURVEILLANCE PLAN		
Environmental Problem/Concern	**Monitoring Activity**	**Responsibility**
3. Ecosystem Health		
Fish and Wildlife Communities	Monitor fish communities via long-term, annual index netting surveys and creel surveys (1 in 5 years)	MNR
	Monitor commercial fish harvests in Severn Sound (carp and baitfish) and walleye outside the Sound	MNR
	Track species deversity: o larval fish survey every 3-5 years o encourage additional sampling of rare species by special interest groups (eg. Muskellunge, Sturgeon, small fish) and index survey of selected littoral habitats every 3-5 years.	DFO/ MNR/interest groups
	Monitoring of reproductive success of Common Terns nesting in the Sound.	CWS
	Monitor waterfowl populations in Matchedash Bay area, by breeding index surveys and harvest surveys.	CWS/MNR/ Interest groups
	Monitor osprey population via active nest counts.	CWS/MNR/ interest groups
	Monitor wetland mammal populations, especially in Matchedash Bay by conducting muskrat house counts.	MNR/ interest groups
	General inventory and biological/ecological assessment of the Map Turtle.	CWS
	Ongoing management and surveillance program at the Wye Marsh and dispersal sites throughout Ontario.	Friends of Wye Marsh Inc./MNR
	Sediment Quality Guidelines, waterfowl gizzard surveys and blood monitoring of susceptible wildlife species (eg. Trumpeter Swans)	MNR/CWS/ interest groups

Table 8.1: MONITORING SURVEILLANCE PLAN		
Environmental Problem/Concern	**Monitoring Activity**	**Responsibility**
3. Ecosystem Health Cont'd:		
Animal Deformities or Reproductive Problems	Use of Severn Sound as a reference area for tumours and deformities in Great Lakes species being tested.	MNR/MOE
	Annual surveys for deformities in double-crested cormorant populations by surveying colonies on South and North Watcher Islands just outside the Severn Sound.	CWS/MNR
Benthos	General benthos survey of Severn Sound every 7 years.	MOE
	Follow-up survey of benthos in Penetang Bay one year following the start-up of full operation of the upgraded Main St. and Fox St. sewage plants. Sampling should include a seasonal component.	MOE
	Sampling of mayfly *Hexagenia*. Research studies ongoing in the Great Lakes will provide frequency and time of year.	MOE
Phytoplankton and Zooplankton Populations	Sampling of phytoplankton and zooplankton as a component of open water quality monitoring.	MOE
4. Bacterial Contamination	Monitoring of public bathing beaches for a minimum of once a week prior to and throughout the bathing season.	MOH
	Monitoring of tributaries and STPs	MOE

Table 8.1: MONITORING SURVEILLANCE PLAN		
Environmental Problem/Concern	**Monitoring Activity**	**Responsibility**
5. Trace Contamination		
Fish and Wildlife Consumption	Collection and analysis of: o sport fish tissue samples to follow trends in mercury contamination (smallmouth bass, largemouth bass and northern pike) on a 3 year frequency. Walleye on a reduced frequency, every 5 years as the population rehabilitation allows.	MNR/MOE
	o carp, white sucker and bullhead tissue samples to follow trends in persistent organic contaminants on a 3 year frequency.	MNR/MOE
	o fish-eating birds' eggs in Severn Sound for persistent toxic chemicals on a 4 year frequency.	CWS/MNR
	o fish-eating birds and/or waterfowl at least once every five years.	CWS/MNR
	Surveillance monitoring of discharges and sediments for persistent chemicals to identify active sources to Severn Sound (sludge, biomonitoring, sediment sampling).	MOE/Municipality
Fish and Wildlife Tainting	Survey of anglers on taste as part of routine creel survey.	MNR

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MEASUREMENTS AND UNITS

mg/L = milligram per litre = part per million (ppm)*

ug/L = microgram per litre = part per billion (ppb)*

ng/L = nanogram per litre = part per trillion (ppt)*
(one trillionth part of a gram)

pg/L = picograms per litre = part per quadrillion (ppg)

ug/g = microgram per gram = part per million (ppm)

mg/kg = milligram per kilogram = part per million (ppm)

ug/kg = microgram per kilogram = part per billion (ppb)

ng/kg = nanogram per kilogram = part per trillion (ppt)

L/d = litre per day

m^3/d = cubic meters per day

mgd = millions of gallons per day

cfs = cubic feet per second

m^3/s = cubic meters per second

kg/d = kilograms per day

lbs/d = pounds per day

kg/yr = kilograms per year

t/yr = tonnes per year

uS/cm = microsiemens per centimetre (conductivity)

HOW SMALL ARE THESE MEASUREMENTS?

PARTS PER MILLION (PPM), PARTS PER BILLION (PPB), PARTS PER TRILLION (PPT):

These terms have worked their way into common expressions of air and water pollutant measurements. But other than the experts, who can grasp what these units really mean in the absence of some terms of reference?

Consider these proportions in more readily understandable expressions.

One part per million:
= one inch in 16 miles
= one minute in two years

One part per billion:
= one inch in 16,000 miles
= one second in 32 years

One part per trillion:
= one hair's width compared to the circumference of the earth
= one second in 320 centuries

<u>At what point are chemicals perceived?</u>

Table salt in water becomes somewhat unpalatable at one part per thousand; swimmers can detect chlorine in a pool at one part per million; and sensitive noses can detect the odour of fuel oil at one part per billion. One part per trillion of anything is not detectable without the use of advanced analytical equipment, although highly toxic compounds may be of great concern even at concentrations in the part per trillion range.

COMMON ACRONYMS

Al	=	Aluminum
AOC	=	Area of Concern
As	=	Arsenic
BMP	=	Best Management Plan
BOD	=	Biochemical Oxygen Demand
C of A	=	Certificate of Approval
Cd	=	Cadmium
[Chl a]	=	Chlorophyll a concentration
COA	=	'Canada - Ontario Agreegment' Respecting Great Lakes Water Quality
Cr	=	Chromium
CSO	=	Combined Sewer Overflow
Cu	=	Copper
CURB	=	'Clean Up Rural Beaches' Program
CWS	=	Canadian Wildlife Service
D.O.	=	Disolved Oxygen
DDE	=	A breakdown product of DDT
DDT	=	A very persistent chlorinated pesticide, phased out in 1969, but still persists in sediments and biota
DFO	=	Department of Fisheries and Oceans (Federal)
EHJV	=	Eastern Habitat Joint Venture of the NAWMP
Env. Can.	=	Environment Canada (Federal)
EPA	=	Environmental Protection Act

Fe	=	Iron
FHMP	=	Fish Habitat Management Plan
GBI	=	Georgian Bay Islands National Park
GIS	=	Geographical Information System
GLWQA	=	Great Lakes Water Quality Agreement
HCB	=	Hexachlorobenzene
Hg	=	Mercury
HWC	=	Health and Welfare Canada
IBI	=	Index of Biotic Integrity
IC	=	Implementation Committee
IJC	=	International Joint Commission
Mg	=	Magnesium
MHC	=	(Penetanguishene) Mental Health Centre
MISA	=	Municipal/Industrial Strategy for Abatement
MMA	=	Ontario 'Ministry of Municipal Affairs'
Mn	=	Manganese
MNR	=	Ontario 'Ministry of Natural Resources'
MOH	=	Ontario 'Ministry of Health'
MTR	=	Ontario 'Ministry of Transporation'
NAWCC	=	North American Wetlands Conservation Council
NAWMP	=	North American Waterfowl Management Plan
Ni	=	Nickel
NSSCIA	=	North Simcoe Soil and Crop Improvement Association

O & M	=	Operating and Maintenance
OMAF	=	Ontario Ministry of Agricluture and Food
OMOE	=	Ontario Ministry of the Environment
OMOEE	=	Ontario Ministry of Environment and Energy (as of February 3, 1993)
PAC	=	Public Advisory Committee
Pb	=	Lead
PCB	=	Polychlorinated Biphenyl
PIP	=	Public Involvement Program
PWQO/G	=	Provincial Water Quality Objectives/Guidelines
RAP	=	Remedial Action Plan
RIPAC	=	RAP Implementation Public Advisory Committee
RODP	=	Remedial Options Discussion Paper
SDV	=	Secchi Disk Visibility
STP	=	Sewage Treatment Plant
[TP]	=	Total phosphorus concentration
WPCP	=	Water Pollution Control Plant
Zn	=	Zinc

GLOSSARY

ABSORPTION	Penetration of one substance into the body of another.
ACCUMULATION	Storage of a chemical or substance in tissue. May also apply to the storage and concentration of a chemical in aquatic sediments to levels above those that are present in the water column.
ACUTE	Involving a brief exposure to a stimulus. In toxicity tests, a duration of 96 hours is typically considered acute.
ACUTE TOXICITY	Mortality or other toxic effects that are produced within a short period of time, usually 24 to 96 hours.
ADAPTATION	Change, often genetically based, in the structure, forms or behaviour of an organism to accommodate changing environmental conditions. See also Acclimation.
ADSORPTION	The taking up of one substance onto the surface of another.
ANAEROBIC	The condition associated with an absence of free oxygen in the environment.
ALGA(E)	Simple one-celled or many-celled micro-organisms, usually free-floating, capable of carrying on photosynthesis in aquatic ecosystems; a form of aquatic plant.
ALGAL BLOOMS or SCUMS	Excessive growths of algae and aquatic plants that form unsightly scums and layers of turbid water, impairing the water for recreational, domestic and aesthetic uses.
ALKALINITY	A measurement of acid neutralization of buffering capability of a solution (see pH).
AMBIENT WATER	The water column or surface water (lake, river, etc.) as opposed to groundwaters or sediment pore water.
ANAEROBIC	living, acting or occurring in the absence of free oxygen.
ANOXIA	The absence of oxygen. In aquatic ecosystems this refers to the absence of dissolved oxygen in water, a situation which cannot be tolerated by most aquatic organisms.

AQUATIC	Living in water.
ASSIMILATION	The absorption, incorporation and metabolism of substances. For example nutrients can be absorbed and processed, or assimilated, by an organism or ecosystem.
ATMOSPHERIC	Pollution from the atmosphere associated with dry deposition in the form of
DEPOSITION	dust, wet deposition in the form of rain and snow, or as a result of vapour exchanges.
BENTHIC	Of or living on or in the bottom of a water body; benthic region, benthos.
BENTHOS	Bottom dwelling organisms, the benthos comprise: 1) stationary animals such as sponges, some worm species and attached algae; 2)creeping forms such as snails and flatworms; and 3)burrowing forms which include most clams, worms, freshwater shrimp, mayflies and midges and other insect larvae.
BENZO(A)PYRENE	A PAH (polyaromatic hydrocarbon) which is a suspected carcinogen found in cigarette smoke. It is a byproduct of combustion and is released to the aquatic environment from industrial processes such as steel and aluminum making.
BIOACCUMULATION	Uptake and retention of substances, including nutrients and contaminants, by an organism from both its environment (i.e. directly from the water) and its food.
BIOASSAY	A biological assessment of water or sediment designed to evaluate toxicity of to an organism.
BIOAVAILABILITY	The portion of the total chemical(s) in the surrounding environs, i.e. water, sediment, which is available for uptake by organisms (plant, animal). The biologically reactive amount of a substance in the environment.
BIOCHEMICAL OXYGEN DEMAND (BOD)	The amount of dissolved oxygen required for the bacterial decomposition of organic waste in water.

BIOCONCENTRATION	The ability of an organism to concentrate substances within its body at concentrations greater than in its surrounding environment or food.
BIOMASS	Total weight of all or specific organisms usually expressed for a given area or volume of water or sediment.
BIOMONITORING	The use of organisms to test the toxic effects of substances in effluent discharges or the surrounding environment as well as the chronic toxicity of low-level pollutants in the aquatic environment.
BIOTA	Plants and animals.
CARCINOGEN	Cancer-causing chemical or substance.
CHIRONOMID	Any of a family of midges that lack piercing mouth parts as adults. Larval forms are sediment dwelling burrowing invertebrates that are an important food source for bottom feeding species such as fish.
CHLOROPHYLL A	The green pigment present in most plants and algae where photosynthesis takes place.
CHRONIC	Duration of exposure to an environmental stress that is prolonged.
CHRONIC TOXICITY	Toxicity observed following a long duration of exposure, that produces an adverse effect on organisms. The end result of chronic toxicity can be death although the usual effects are sublethal; e.g. reproduction or growth inhibition. These effects can be reflected by change in the productivity and structure of the population and community. See also Acute Toxicity.
COMMUNITY	Group of populations of plants and animals interacting in given place; ecological unit used in a broad sense to include groups of various sizes and degrees of integration.
CONSUMPTIVE USE	Permanent removal of water from a water body. Consumptive use may be due to evaporation, agricultural use, or incorporation of water into a manufactured product.

CONTAMINANT	A substance foreign to a natural system or present at unnatural concentrations in air, water, soil or food, causing use of those things to be limited. A naturally occurring substance may be found to exceed government guidelines, or objectives and be called a contaminant, e.g. metals.
CONTAMINATION	The introduction of pathogenic or undesirable micro-organisms, toxic and other deleterious substances which can render water, air soils or biota unfit for use or unhealthy.
CRITERIA	Numerical limits of pollutants typically established to protect the aquatic ecosystem and human use of the ecosystem.
CRITERIA, WATER QUALITY	Designated concentrations water quality constituents based on scientific evidence and judgement, that, when not exceeded will protect an organism, a community of organisms, or a prescribed water use with an adequate degree of assurance.
DENSITY	Number of individuals in a given space.
DIELDRIN	A chlorinated pesticide that is persistent and bioaccumulates in all living organisms; causes reproductive disorders in wildlife and is a known carcinogen.
DIOXIN	A group of approximately 75 chemicals of the chlorinated dibenzodioxin family, including 2.3.7.8 - tetrachlorodiobenzo-para- dioxin (2,3,7,8 - TCDD) which is generally considered the most toxic form. Can be formed when naturally occurring organic molecules come in contact with chlorine introduced into the environment from such activities as the bleaching of pulp.
DIFFUSE SOURCE	A source of pollution that is not distinct and is widely distributed, such as atmospheric deposition and agricultural or urban runoff.
DISSOLVED OXYGEN	The amount of oxygen dissolved in water.
DRAINAGE BASIN	A body of water and the land area drained into it.
DREDGING GUIDELINES	Numerical guidelines with primary emphasis on the concentrations of toxic materials in sediment to be dredged, with directions designed to minimize the adverse effects of sediment disposal.

"DRY" INDUSTRY	An industry which does not produce liquid waste as compared to a "wet" industry
ECOSYSTEM	The interacting complex of living organisms and their non-living environment; the biotic community and its abiotic environment.
EFFLUENT	Waters discharged from facilities to either wastewater sewers or to surface waters.
EROSION	The wearing away and transportation of soils, rocks and dissolved minerals from the land surface shorelines or river bottom by rainfall, running water, wave or current action.
EUTROPHICATION	The process of nutrient enrichment that causes high productivity and biomass in an aquatic ecosystem. Eutrophication can be a natural process or it can be a cultural process accelerated by an increase of nutrient loading to a waterbody by human activity.
EXOTIC SPECIES	Species that are not native and have been intentionally or inadvertently introduced into the system, such as zebra mussel and purple loosestrife.
FATE	As in the fate of a contaminant: the result of material deposition via transport, bioaccumulation, transformation and degradation, i.e. sediment, water column, air or biota.
FLUVIAL	Of or relating to a river.
FOOD CHAIN	The organization of biota in which organisms in higher trophic levels gain energy by consuming organisms at lower trophic levels; the dependence for food of organisms upon others in a series, beginning with bacteria and plants and ending with carnivores.
GOAL	An ideal, aim or objective towards which to strive; it may represent an ideal condition that is difficult, if not impossible to attain technically, sociologically, environmentally, or economically.
GREAT LAKES BASIN ECOSYSTEM	The interacting components of air, land, water and living organisms including humans, within the drainage basin of the St. Lawrence River at or upstream from the point at which this river becomes the international boundary between Canada and the United States (from Article 1 of the 1978 GLWQA).

GREAT LAKES WATER QUALITY AGREEMENT (GLWQA)	A joint agreement between Canada and the United States which commits two countries to restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes Basin Ecosystem (from Article 2 of the 1978 GLWQA). Originally signed in 1972 the Agreement was amended in 1978 and 1987.
GROUNDWATER	Water entrained and flowing below the surface which may supply water to wells and springs.
GUIDELINE	Any suggestion or rule that guides or directs; i.e. suggested criteria for programs or effluent limitations.
HAZARDOUS SUBSTANCES	Chemicals considered to be a threat to humans in the environment including substances which (individually or in combination with other substances) can cause death, disease (including cancer), behavioural abnormalities, genetic mutations, physiological malfunctions or physical deformities.
HEXACHLORO-BENZENE	A by-product of the chemical industry, created during the production of solvents and some pesticides. It is a persistent carcinogen.
INSECTICIDE	Substances or a mixture of substances intended to destroy or repel insects.
IN SITU	In place; occurring in nature.
INTERSTITIAL	Of, forming, or occurring in interstices or pores between sediment particles; situated between the cellular components of an organ or structure.
LEACHATE	Materials that percolated through solids, soils, solid wastes and rock layers, that can enter the water column.
LETHAL	Causing death.
LITTORAL ZONE	Productive shallow-water zone of lakes with light usually penetrating to the bottom; often occupied by rooted aquatic plants.
LOADINGS	Total mass of a substance added to a water body over a specified time; e.g. kilograms per year of phosphorus.

MACROPHYTE	Plant life, larger than algae, found in bodies of water.
MERCURY	Recognized as a dangerous substances for many years because it bioaccumulates and biomagnifies through the food chain, and can affect the central nervous system. It has entered the Great Lakes from a variety of industrial processes and natural sources.
MESOTROPHIC	Having a moderate amount of dissolved nutrients (compared with eutrophic)
METABOLITES	Biodegraded chemical end products - the product of a bio-transformation process. Pollutants or natural substance produced from metabolic activity.
MIREX	A pesticide which has been found in significant quantities in Lake Ontario. It accumulates in the food chain, causes reproductive problems and cancer.
MODELLING	Mathematical simulation of actual conditions often used to predict the fate of nutrients, bacteria, or other chemicals in the ecosystem.
NON-POINT SOURCE	Source of pollution in which pollutants are discharged over a widespread area or from a number of small inputs rather than from distinct, identifiable sources. See also diffuse source.
NUTRIENT	A chemical that is essential for the growth and development of organisms. Some examples include phosphorus and nitrogen.
ORGANOCHLORINE	An organic compound which includes chemically bound chlorine. Many organochlorines are formed in industrial processes whenever chlorine or chlorine based compounds are used. Thousands of chlorinated organic compounds exist but only a small proportion of those in industrial processes have been identified. Some are used as pesticides (such as aldrin, DDT or dieldrin)
OXIC-ANOXIC	Oxic - oxygen present Anoxic - no oxygen present
PASSERINE	Of or related to a classification of songbirds that have perching habits

PATHOGEN	A disease - causing agent such as bacteria, viruses, and parasites.
PERSISTENT TOXIC SUBSTANCE	Any toxic substance with a long half-life in water or sediment. can be defined as persisting for more than eight weeks.
PESTICIDE	Any substance used to kill plants, insects, fungi or other organisms; include herbicides, insecticides, algicides, fungicides.
PHOSPHORUS	An non-metallic element that occurs naturally in igneous and other types of rocks and may enter the aquatic environment through weathering of rock or precipitation. Some uses for phosphorus include soaps, detergents, fertilizer production, pesticides and insecticides. Domestic and livestock wastes, industrial effluents and agricultural drainage from fertilized land contribute phosphorus to waters.
PHOTOSYNTHESIS	A process occurring in the cells of green plants and some micro-organisms in which solar energy is transformed into stored chemical energy.
PHYTOPLANKTON	Minute, microscopic aquatic vegetative life; plant portion of the plankton (free floating aquatic plants); the plant community in marine and freshwater situations which floats free in the water and contains many species of algae and diatoms.
POINT SOURCE	A source of pollution that is distinct and identifiable, such as an outfall pipe from an industrial plant.
POLLUTION (WATER)	Anything causing or inducing objectionable conditions in any watercourse and adversely affecting the environment and use or uses to which the water thereof may be put.
POTABLE WATER	Water suitable, on the basis of both health and aesthetic considerations, for drinking or cooking purposes.

PCBs	PCBs are a group of chlorinated compounds first commercially developed in the late 1920s. They are not of natural origin or formed in the natural environment so their presence can always be attributed to man's activities. PCBs are stable and relatively inert compounds; they break down very slowly in the environment and are destroyed by burning only at very high temperatures. These properties led to widespread use of PCBs as electrical transformer insulating fluids, extreme pressure oils and greases, hydraulic fluids and as fire retardants and plasticizers in products such as paints, inks, caulking compounds and sealants. PCBs tend to persist for years in the natural environment. This, coupled with the fact that they bioaccumulate readily in the aquatic ecosystem, has meant that "top predator" species of fish with high fat content in their bodies have, in some Ontario waters, accumulated PCBs to contaminating levels.
PRIMARY TREATMENT	Mechanical removal of floating or settleable solids from wastewater
PUBLIC	Any person, group, or organization.
RESUSPENSION	(of sediment) The remixing of sediment particles and pollutants back into the water by storms, currents, organisms and human activities such as dredging and shipping.
RIPARIAN	Relating to or living or located on the bank of a natural watercourse (as a river) or sometimes of a lake or tidewater.
RISK ASSESSMENT	Process for estimating the likelihood that toxic response could take place if people or animals were exposed to certain concentrations of toxic chemical(s) over a given period of time.
SECCHI DISC	A standard size metal disc painted in black and white quarters and suspended by a rope from its centre. The secchi disc is used to estimate water clarity by lowering the disc beneath the lake's surface and noting the depth at which it disappears from view.
SECONDARY TREATMENT	Bacterial action on the waste remaining from primary treatment of sewage to decompose organic components of the waste.
SEDIMENT	The fines or soils on the bottom of the river or lake.

SEICHE	An oscillation in water level from one end of a lake to another due to winds or atmospheric pressure. Most dramatic after an intense but local weather disturbance passes over one end of a large lake.
SESSILE	An animal that is attached to an object or is fixed in place (e.g. barnacles).
SEWER, SANITARY	A municipal sewer for the collection and transmission of domestic, commercial and industrial wastes to treatment plants; not including land drainage or storm water runoff.
SEWER, STORM	A municipal sewer for the collection and transmission of storm water runoff, land surface water and water from soil drainage not including any industrial wastes other than unpolluted cooling waters.
SLUDGE	Solids produced by wastewater (sewage) treatment facilities and some industrial processes.
SOLUBILITY	Degree to which a substance can be dissolved.
STABILITY	Absence of or predictable fluctuations in populations; ability to withstand perturbations without large changes in community composition or function.
STANDARD	(Water Quality) Regulatory limits concerning the concentration of chemical(s)/substance(s) permitted in effluent discharges and/or waterway(s). Standards are generally dependant on designated use(s).
SUBACUTE	Involving a stimulus whose duration is between acute and chronic.
SUB-LETHAL	Involving a response to a stimulus below the level that causes death.
SUSPENDED SEDIMENT	Particulate matter suspended in water.
SUSTAINABLE DEVELOPMENT	Development which meets the needs of the present generation without compromising the ability of future generations to meet their own needs.

SYNTHESIS	The production of a substance by the union of elements or simpler compounds.
TAXONOMY	The process of identifying an organism by its structure.
TERATOGEN	A substance that increases the incidence of birth defects.
TERATOGENICITY	The ability of a substance to produce irreversible birth defects, or anatomical or functional disorders as a result of an effect on the developing embryo.
THRESHOLD	The chemical concentration or dose that must be reached before a given reaction occurs.
TOXIC SUBSTANCE	As defined in the Great Lakes Agreement, any substance that can cause death,disease, behavioural abnormalities cancer, genetic mutations, physiological or reproductive malfunction or physical deformities in any organism or its off-spring, or which can become poisonous after concentration in the foodchain or in combination with other substances.
TOXICANT	Substance capable of producing adverse effect(s) in the ecosystem, resulting in injury, disfunction or even death.
TOXICITY	The quality of being toxic or poisonous.
TRACE CONTAMINANTS	Toxic and other deleterious substances found in trace concentrations in the environment.
TROPHIC LEVEL	Functional classification of organisms in a community according to feeding relationships; the first trophic level includes green plants, the second level includes herbivores; etc.
TROPHIC STATUS	A measure of the biological productivity in a body of water. Aquatic ecosystems are characterized as oligotrophic (low productivity), mesotrophic (medium productivity) or eutrophic (high productivity).
TURBIDITY	A measure of clarity in water.
UBIQUITOUS	Present, or seeming to be present, everywhere at the same time.
UPTAKE	The transfer of a substance into an organism.

WATER QUALITY OBJECTIVES	Under the Great Lakes Water Quality Agreement, goals set by the Governments of Canada and the United States for protection of the uses of the Great Lakes.
WATER QUALITY STANDARD	A criterion or objective for a specific water use that is incorporated into enforceable regulations.
ZOOPLANKTON	The animal portion of the community that live suspended in the water column.

Appendix 2.1: List of Phytoplankton Found in Severn Sound

TABLE 2. The common phytoplankton genera of Severn Sound; station P1, between 1973 to 1990. Dominant genera (≥20% of class respective seasonal mean biovolume) during each ice free season are indicated by "X".

STATION P1	YEAR								
Taxon	73	75	79	81	83	85	87	89	90
CYANOPHYTES									
Anabaena	X	X	X	X	X	X	X	X	X
Aphanizomenon	X	X	X	X	X				
Aphanocapsa									
Aphanothece									
Chroococcus									
Coelosphaerium						X			X
Gomphosphaeria									
Lyngbya									
Merismopedia									
Microcystis									X
Oscillatoria			X						
CRYPTOPHYTES									
Chroomonas									
Cryptomonas	X	X	X	X	X	X	X	X	X
Katablepharis									
Rhodomonas	X		X						
BACILLARIOPHYTES									
Achnanthes									
Asterionella		X	X	X	Y	X			X
Cossoneis									
Cyclotella						Y			
Diatoma									
Fragilaria	X	X	X		Y			X	
Melosira	X	X			X		X	X	X
Navicula									
Nitzschia									
Rhizosolenia									
Stephanodiscus	X	X	X	Y			X	X	X
Surirella									
Synedra									Y
Tabellaria			X	X	X	X			Y
DINOPHYTES									
Ceratium	X	X	X	X					
Glenodinium									
Gymnodinium									
Peridiniopsis									
Peridinium						X	X	X	X
Unid. Dinophytes					X	X			
CHRYSOPHYTES									
Chromulina									
Chrysocromulina		X	X		X	X	X	X	X
Chrysolykos									
Dinobryon					X				
Mallomonas	X	X	X		X	X	X	X	X
Ochromonas									
Salpingoeca						X			
Synura					X				
Unid. Chrysomonads				X					
Uroglena									X
Uroglenopsis									

Taxon	73	75	79	81	83	85	87	89	90
CHLOROPHYTES									
Actinastrum									
Ankistrodesmus	X								
Botryococcus									
Carteria		X							
Chlamydomonas			X	X	X	X	Y	X	Y
Chlorella									
Chodatella									
Closterium					Y				
Coelastrum	X	X	X					X	
Cosmarium						Y			
Crucigenia									
Dictyospherium									Y
Eudorina									
Franceia									
Gloeocystis				X		Y	X	X	
Golenkinia									
Gonium									
Gorenkinia									
Gyromitus									
Micractinium									
Monoraphidium									
Mougeotia	X								
Nephrochlamys									
Nephrocytium									
Oocystis		X		X	X	Y		Y	Y
Pandorina	X								
Pediastrum									
Pedinomonas									
Polytoma									
Quadrigula									
Schenedesmus		X						Y	Y
Schroederia									
Selenastrum									
Sphaerocystis									
Staurastrum	X								Y
Tetrastrum									
Tetraedron									Y
Treubaria									

Note: Y=(15 < x> 19%)
Unid. =(Unidentified)

Appendix 2.1 Cont'd:

TABLE 3. The common phytoplankton area of Severn Sound; station BS, between 1973 to 1990. Dominant area (≥10% of class respective seasonal mean biovolume) during each ice free season are indicated by "X".

STATION BS	YEAR								
Taxon	73	75	79	81	83	85	87	89	90
CYANOPHYTES									
Anabaena	X	X	X	X		X	X	X	X
Aphanizomenon	X		X		X			Y	
Aphanocapsa									
Aphanothece									
Chroococcus	X								
Coelosphaerium								X	X
Gleotrichia sp. (epiphyte)							Y	X	X
Gomphosphaeria	X								
Lyngbya									
Merismopedia									
Oscillatoria									
Phormidium									
Rhabdoderma									
Rhapidiopsis									
CHRYSOPHYTES									
Bicoeca									
Chromulina									
Chroococcus									
Chrysochromulina			Y						
Chrysolykos									
Chrysosphaerella					Y				
Dinobryon		X				X			X
Kephyrion									
Mallomonas					X		X	X	X
Ochromonas									
Salpingoeca									
Stelecomonas									
Synura	X		Y		Y				
Unid. Chryophytes		X	X						
Uroglena		X	Y		Y	X	X	X	X
Uroglenopsis	X								
BACILLARIOPHYTES									
Achnanthes									
Amphipleura									
Amphora									
Anomoeoneis									
Campylodiscus									
Cocconeis									
Cyclotella					X	Y	Y	Y	
Cymatopleura									
Cymbella									
Diatoma						Y		X	
Epithemia									
Fragilaria	Y	X						X	
Gomphonema									
Gyrosigma									
Melosira			Y	X					X
Navicula									X
Nitzschia									
Rhizosolenia									
Rhopalodia									
Stephanodiscus	Y	X			Y		X		
Synedra			X	Y	X				X
Tabellaria						X			

Taxon	73	75	79	81	83	85	87	89	90
DINOPHYTES									
Ceratium			X				Y		X
Glenodinium									
Gymnodinium									X
Peridinium								X	X
Unid. Dinophytes		X	X	X	X				
CRYPTOPHYTES									
Cryptomonas	X	X	X	X	X	X	X	X	X
Katablepharis									
Rhodomonas									
CHLOROPHYTES									
Actinastrum									
Ankistrodesmus									
Arthrodesmus									
Botryococcus									
Carteria							Y		
Chlamydomonas				X	X	X	Y	X	X
Chlorella									
Chodatella									
Closterium									
Coelastrum			X			Y			
Cosmarium									
Crucigenia									
Dictyosphaerium	X								
Elaktothrix									
Franceia									
Gloecystis					X		X	X	
Gloeotila									
Golenkinia									
Gyromitus									
Koliella									
Lagerheinia									
Micractinium									
Monoraphidium									
Mougeotia						X			
Oocystis	Y						Y		
Pandorina									
Paramastix									
Pediastrum	Y								
Planktonema									
Polytoma									
Quadrigula									
Scenedesmus									X
Selenastrum									
Tetraedron									
Tetrastrum									
Treubaria									

Note: Y =(15< x . 19%)
Unid. =(Unidentified)

Appendix 2.2:

The Common Limnetic Zooplankton of Severn Sound

(Year of first recorded appearance: *-1986, **-1989)

Cladocerans:
Acroperus harpae
Alona sp.
Bosmina longirostris
Bythotrephes cederstroemi *
Ceriodaphnia quadrangula
Ceriodaphnia sp.
Chydorus sphaericus
Daphnia ambigua
D. parvula
D. pulex
D. retrocurva
D. galeata mendotae
D. longiremis
Diaphanosoma birgei
D. brachyurum
Eubosmina coregoni
Holopedium gibberum
Ilyocryptus spinifer **
Leptodora kindtii
Pleuroxus hamulatus **
Polyphemus pediculus
Sida crystallina
Simocephalus serrulatus
S. vetulus

Calanoid Copepods:
Calanoid copepodid
Calanoid nauplii
Diaptomus ashlandi
D. minitus
D. sicilis
D. reighardi
D. oregonensis
Epischura lacustris
Eurytemora affinis
Limnocalanus macrurus **

Cyclopoid Copepods:
Cyclopoid copepodid
Cyclopoid nauplii
Cyclops vernalis
C. scutifer
C. bicuspidatus thomasi
Eucyclops speratus
Macrocyclops albidus **
Mesocyclops variatus
Mesocyclops edax
Paracyclops fimbriatus poppei
Tropocyclops prasinus mexicanus

Appendix 2.3: Habitat Changes in Severn Sound

Severn Sound Boat Slip Count Estimated From Air Photos 1931-1987

Location	1931	1951	1965	1973	1982	1987	1989*
Penetang Harbour	20	22	72	189	375	636	710
Midland Bay	-	-	70	140	603	-	-
Hog Bay	4	11	76	50	175	-	-
Sturgeon Bay	7	14	31	34	54	-	-
Matchedash Bay	-	4	13	50	80	-	-

Source: V. Cairns, Fisheries and Oceans Canada, unpublished data.

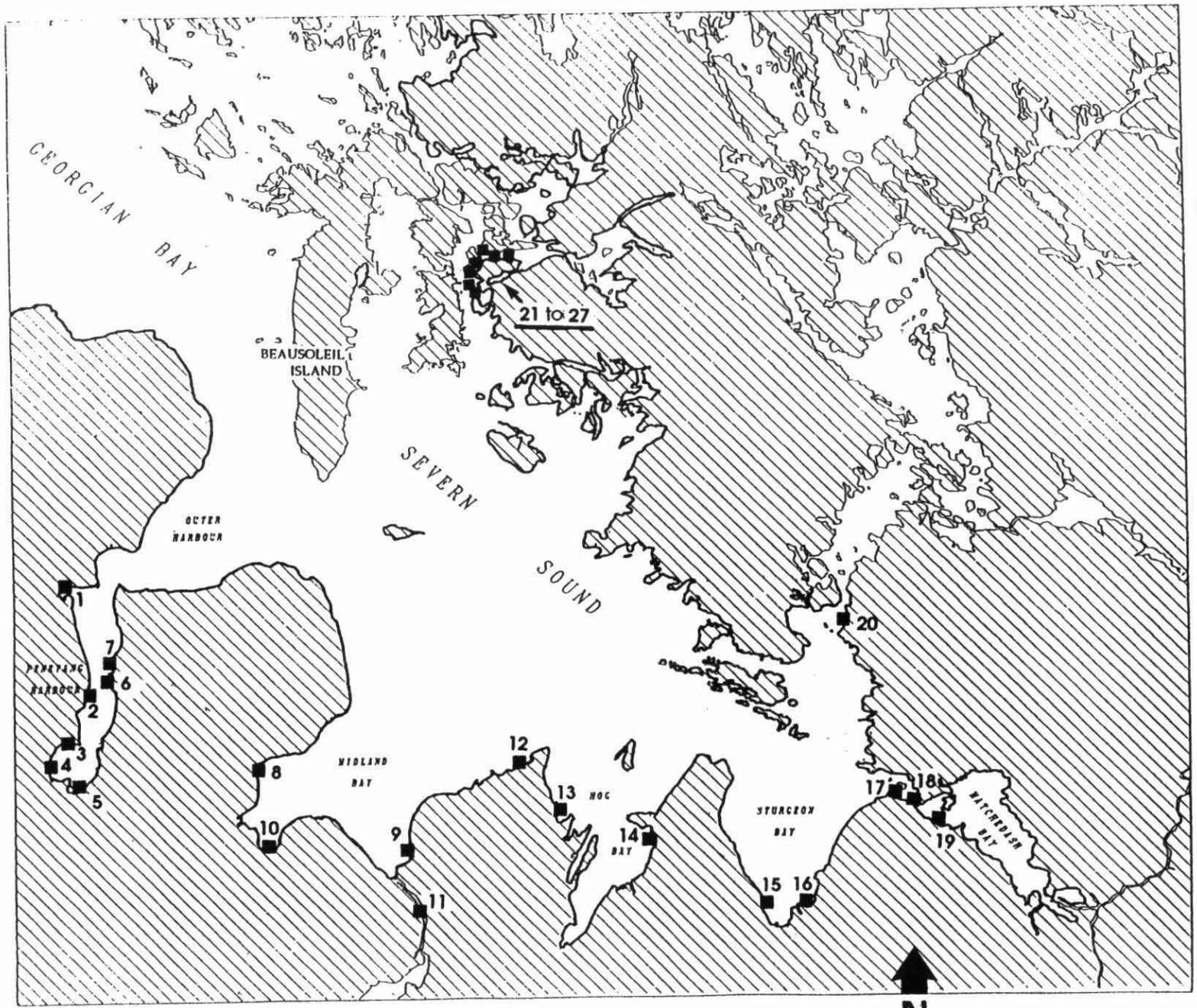
* Actual slip count.

Appendix 2.3 Cont'd:

Evaluated Wetlands Severn Sound Watershed			
Township	Wetland Name	Class*	Area (ha)
Flos	McMahon Creek Swamp	5	189.3
	Orr Lake	1	316.8
Georgian Bay	Quarry Island	3	354.4
Medonte	Copeland Forest Complex	1	2344.7
	Coulson Swamp	1	125.4
	Guthrie Swamp	4	485.3
	Vasy Ducks Unlimited Swamp	2	138.2
Orillia	Marchmont Swamp	3	223.1
	North River Swamp	4	88.2
	Purbrook Creek Swamp	1	661.1
	Silver Creek Swamp	6	26.1
Oro	Bass Lake	1	480.1
Tay	Hog Bay	3	31.6
	Matchedash Bay Marsh	1	1250.1
	Port McNicoll	2	76.9
	Sturgeon Bay Marsh	2	192.1
	Sucker Creek	3	32.0
	Victoria Harbour Marsh	3	39.0
	Wye Marsh	1	743.9
Tiny	Midland Swamp	6	37.6
	Penetang Marsh	3	29.3
	Tiny Marsh	1	659.4
Totals	22 wetlands		8524.6

* according to MNR Wetlands Evaluation

Source: MNR, Midhurst District, as of 1991.



PENETANG HARBOUR
1 Northwest Basin
2 Bay Marine
3 Albert Cove Marina Ltd.
4 Hindson's Marine Ltd.
5 Beacon Bay Marina
6 Bay Moorings
7 Dutchman's Cove

MIDLAND
8 Sunnyside Marina (now Bayport Midland Marina Inc.)
9 Wye Heritage Marina Inc
10 Central Marina
11 Midland Wye River
12 Paradise Point Marina

PORT McNICOLL
13 Duncan's Marina

VICTORIA HARBOUR
14 Queens Cove Marina

STURGEON BAY
15 Caswells Beach
16 Sturgeon Bay Ratepayers Association

WAUBAUSHENE
17 Marshes Waubaushene Marina
18 Pier 69
19 Twin Bridges Marina

PORT SEVERN
20 Lackies By The Bay

HONEY HARBOUR
21 Bayview Marine Resort
22 Honey Harbour Boat Club
23 Honey Harbour Small Motors
24 Paragon Marina and Sports Inc.
25 South Bay Cove Marina
26 South Bay Yacht Club (Brandy's Island)
27 Village Marina Ltd.

APPENDIX 2.3 Severn Sound marinas

Appendix 2.4: Sediment Quality in Severn Sound

Table 1: Physical and nutrient characteristics of surficial sediment, 1988,89.

STN #	SAMPLE DEPTH (m)	LOI mg/g d	TOC mg/g d	TKN mg/g d	TP mg/g d	Eh mV	SOLEXT ug/g	TPCB ng/g	%CLAY	%SILT	%SAND
Penetang Bay											
357		84	34	2.40	0.92		1000		4.82	29.6	64.9
529	6.1	58	26	2.86	0.91	-189	1550	20<W	3.34	58.6	37.6
527	8.1	130	59	7.39	1.38	-276	1455	20<W	TO	TO	TO
561	8.1	130	63	5.90	1.08	-288	1350	20<W	7.80	79.4	12.4
557	6.1	137	64	5.53	1.08	-211	2553	20<W	4.88	79.0	15.1
559	4.1	480	240	5.04	0.66	-310	7250	20<W	TO	TO	TO
556	6.1	140	66	6.07	1.10	-318	2820	20<W	TO	TO	TO
554	6.1	110	54	4.92	1.09	-308	2290	20<W	TO	TO	TO
555	5.1	210	100	5.24	0.95	-320	2830	60<T	TO	TO	TO
525	5.1	61	28	2.77	0.87	-310	630	20<W	TO	TO	TO
553	6.1	52	24	2.47	0.73	-323	1380	20<W	4.71	42.2	52.1
552	7.1	87	62	4.81	1.19	-211	2703	147<T	TO	TO	TO
551	5.1	150	72	7.58	3.05	-318	4120	45<T	TO	TO	TO
550	4.1	125	56	5.48	5.18	-311	3565	20<W	TO	TO	TO
549	3.1	270	130	7.05	2.13	-297	5620	20<W	TO	TO	TO
523	4.1	160	72	6.29	1.14	-320	3310	20<W	TO	TO	TO
522	4.1	170	80	8.22	0.99	-264	3380	20<W	TO	TO	TO
547	4.1	130	60	5.23	0.94	-313	1450	20<W	TO	TO	TO
548	4.1	120	54	4.25	0.90	-294	930	20<W	TO	TO	TO
Mean	5.4	148	71	5.24	1.38	-288	2641	31	5.11	57.7	36.4
(SD)	(1.4)	(96)	(48)	(1.72)	(1.07)	(42)	(1688)	(31)	(1.63)	(22.1)	(22.8)
Sturgeon Bay											
544	3.1	83	34	3.37	0.96	-290	525	20<W	TO	TO	TO
545	3.1	20	8	0.81	1.04	-212	265	20<W	1.93	30.5	67
546	3.1	34	16	1.80	1.06	-310	570	20<W	1.05	45.2	53.3
542	4.1	78	36	4.08	1.01	-292	850	20<W	TO	TO	TO
543	3.6	85	39	4.16	0.94	-289	1030	20<W	TO	TO	TO
536	3.6	96	43	4.75	0.99	-322	1220	20<W	TO	TO	TO
535	4.1	67	31	3.40	0.98	-285	525	20<W	TO	TO	TO
539	3.1	98	46	4.95	1.05	-275	730	20<W	TO	TO	TO
534	3.1	84	40	4.20	1.03	-288	1630	20<W	4.38	31.8	13.55
538	3.5	93	42	4.22	1.07	-293	1350	20<W	TO	TO	TO
541	4.1	130	55	6.48	1.19	-102	1265	20<W	TO	TO	TO
537	4.1	81	36	3.75	1.09	-272	440	20<W	6.58	49.2	43.7
533	3.6	88	40	4.29	1.04	-269	640	20<W	6.44	62.1	31.1
532	4.1	96	43	4.36	1.04	-240	910	20<W	TO	TO	TO
540	4.1	120	52	6.12	1.15	-334	1650	20<W	TO	TO	TO
Mean	3.6	84	37	4.04	1.04	-271	907	20	4.07	43.8	41.7
(SD)	0.4	28	(12)	(1.41)	(0.06)	(55.6)	(435)	(0)	(2.54)	(13.1)	(20.5)
Midland Bay and Tiffin Basin											
517	9.1	53	27	2.03	0.94	-310	2260	85<T	5.98	56.5	36.7
516	8.1	54	25	1.96	0.91	-297	1290	20<W	7.74	60.0	31.4
359	5.1	130	62	5.00	0.90	-298	748	20<W	14.50	74.0	10.8
563	7.1	62	28	3.35	1.17	-300	1390	20<W	4.30	59.2	36.1
564		64	27	2.73	1.04		1190		4.96	69.5	36.1
Mean	7.3	73	34	3.01	0.99	-301	1376	36	7.50	63.8	28.0
(SD)	(1.7)	(32)	(16)	(1.25)	(0.11)	(5.9)	(552)	(32)	(4.12)	(7.5)	(10.7)
Honey Harbour (Control)											
HH'87		75	35	3.36	1.00				9.93	73.3	15.8
HH'88		46	15	1.6	0.9				3.00	40.0	57.0

Note:
- Stations 357 and 359 were sampled in 1989. All other sites sampled in 1988.
- All samples analysed for organochlorine pesticides including DDE - not detected.
- <W = no measurable response, less than reported value.
- <T = trace amount.

Appendix 2.4 Cont'd:

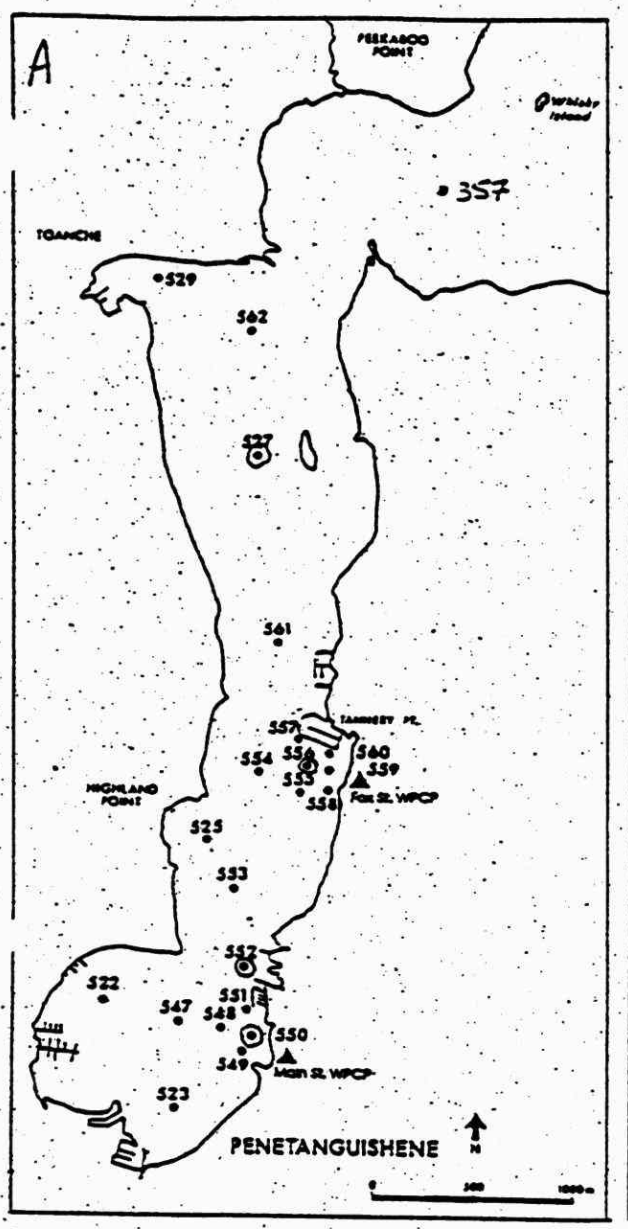
Table 2: Bulk metals concentration in surficial sediment.
(all values in ug/g d.w.)

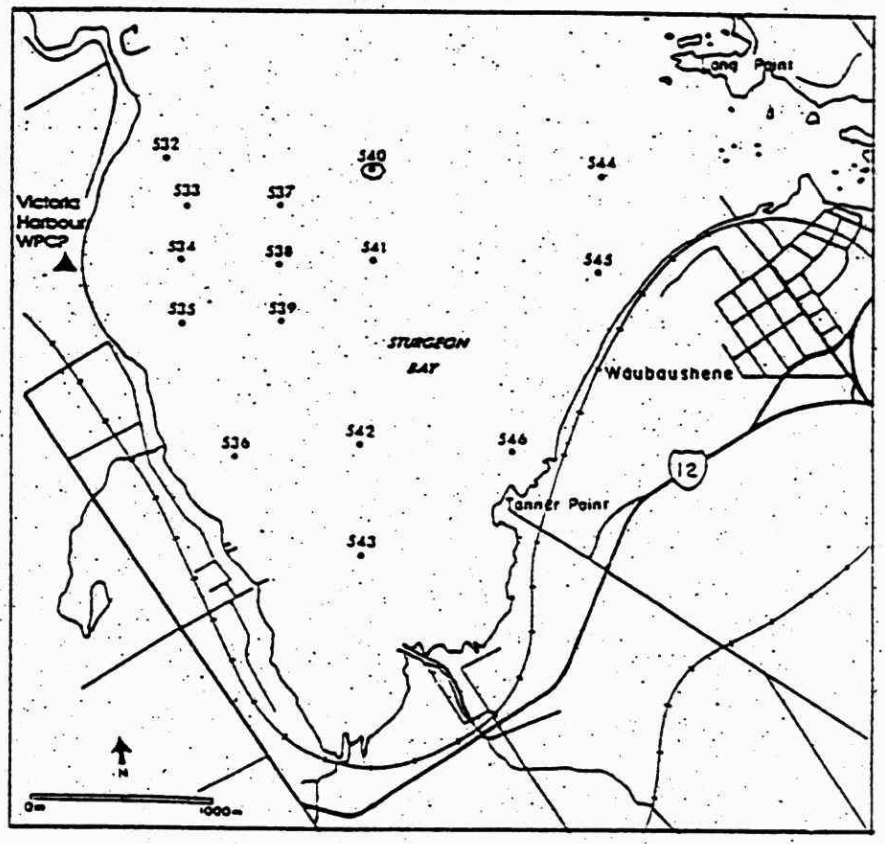
STN #	Al	As	Cd	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Zn
Penetang Bay											
357	2100	2.9	1.10	56	31	31000	0.03	580	36	48	140
529	12000	2.7	0.61	47	22	18000	0.05<T	330	18	39	90
527	23000	5.3	1.20	130	40	34000	0.16	670	40	140	180
561	21000	5.9	1.30	180	44	31000	0.21	620	37	80	180
557	18000	5.3	1.20	123	40	26333	0.24	530	33	76	167
559	6250	5.7	0.84	46	27	12150	0.16	425	16	49	120
556	18000	4.5	1.20	120	39	26000	0.23	580	31	76	160
554	17000	5.0	1.20	100	36	25000	0.20	540	29	72	140
555	14000	5.2	0.91	76	32	21000	0.20	420	26	62	130
525	12000	2.3	0.51	42	18	17000	0.09	380	16	39	75
553	13000	2.0	0.13<T	45	19	20000	0.11	350	18	36	82
552	15556	3.3	0.58	55	43	22556	0.30	398	24	98	158
551	17000	3.1	1.10	58	61	21000	0.47	380	26	110	180
550	16500	2.9	0.70	44	56	17500	0.52	325	20	52	135
549	14000	3.4	0.93	47	52	19000	0.37	310	24	100	190
523	18000	2.8	0.48	53	33	28000	0.10	590	25	53	150
522	17000	3.9	1.00	84	39	26000	0.30	400	30	85	170
547	15000	3.1	0.54	55	28	22000	0.16	410	23	61	110
548	14000	2.5	0.41	47	31	20000	0.17	390	20	50	100
Mean (SD)	14916 (4769)	3.8 (1.3)	0.83 (0.34)	74 (39)	36 (12)	23028 (5574)	0.21 (0.13)	454 (112)	26 (7.2)	70 (28)	140 (36)
Sturgeon Bay											
544	17000	2.2	0.13<T	38	15	25000	0.04<T	520	20	21	94
545	7700	1.0	0.05<W	23	5	18000	0.01<W	320	8	7	30
546	7400	1.0	0.08<T	20	6	14000	0.02<T	290	7	7	31
542	15000	3.0	0.23<T	34	12	23000	0.07	470	16	17	75
543	14000	1.9	0.16>T	34	12	21000	0.04<T	480	15	14	66
536	18000	3.1	0.17>T	39	14	26000	0.03<T	540	19	19	85
535	13000	2.2	0.24<T	31	12	20000	0.03<T	430	15	16	69
539	18000	3.5	0.45	42	16	27000	0.04<T	600	21	23	97
534	16500	3.3	0.13<T	36	14	23500	0.07<T	460	18	13	68
538	15000	3.2	0.64	36	14	24000	0.11	540	18	21	82
541	22333	4.9	0.32	52	21	32333	0.11	777	27	31	123
537	14000	3.2	0.45	34	12	22000	0.09	630	17	22	77
533	14000	3.1	0.29	32	13	21000	0.10	520	17	20	81
532	20000	3.4	0.18<T	44	17	28000	0.12	680	22	25	100
540	26000	4.3	0.21<T	59	23	35000	0.11	780	31	34	140
Mean (SD)	15862 (4862)	2.9 (1.1)	0.25 (0.16)	37 (10)	14 (5)	23989 (5316)	0.07 (0.04)	536 (142)	18 (6)	20 (7)	82 (29)
Midland Bay and Tiffin Basin											
517	13000	2.2	0.39	39	33	21000	0.13	410	21	70	110
516	15000	2.4	0.30	41	24	23000	0.13	410	22	46	91
359	17000	3.3	0.19	55	34	22000	0.14	443	29	65	130
563	12000	1.8	0.39	36	18	20000	0.09	350	18	40	80
564	13000	2.4	0.28	42	20	22000	0.09	470	22	37	83
Mean (SD)	14000 (2000)	2.4 (0.5)	0.32 (0.08)	43 (7)	26 (7)	21600 (1140)	0.12 (0.02)	417 (45)	22 (4)	52 (15)	99 (21)
HH87	19000	4.3	1.10	44	21	31000	0.08	900	25	37	110
HH88	10000	2.1	0.30	22	11	21000	0.02	455	15	20	62
LEL		6	0.6	26	16	20000	0.20	460	16	31	120
SEL		33	10	110	110	40000	2.0	1100	75	250	820
GSC		1	0.66	60.4	20		0.129		14	9	103
(sd)		(1)	(0.34)	(15.8)	(8)		(0.045)		(6)	(10)	(44)

HH = Honey Harbour reference sediment
LEL = Provincial Lowest Effect Level
SEL = Provincial Severe Effect Level
GSC = Geological Survey of Canada lake sediment survey data for Severn Sound Area

Appendix 2.4 Cont'd:

Legend:
- ● 1988, 1989 sampling locations
- ⊙ 1990 bioassessment locations





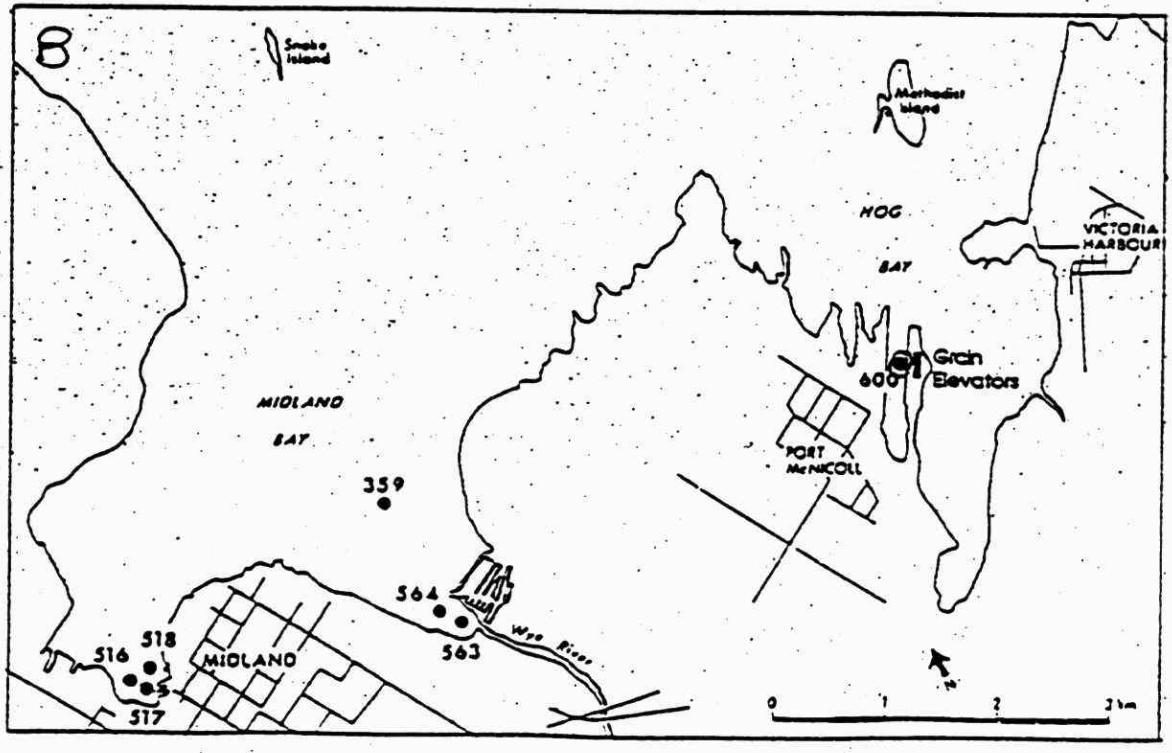


FIGURE : 1988 Surficial Sediment Sampling Locations

Appendix 2.5

ORGANOCHLORINE AND MERCURY RESIDUES IN YOUNG-OF-THE-YEAR SPOTTAIL SHINERS FROM SEVERN SOUND - 1987

Site Number	N	Fish Size (mm)	% Lipid	PCB (ng/g wet)	DDE (ng/g wet)	HCB (ng/g wet)	Mercury (ng/g wet)
1 Beausoleil Island	7	58±4	4.2±0.4	ND	7±2	ND	29±7
2 Penetang Bay - Michaud Pt.	7	54±3	4.2±0.3	ND	6±3	ND	11±4
3 Penetang Bay - Asylum Pt.	7	58±4	4.3±0.4	ND	11±8	2±1	23±5
4 Penetang Bay - Tannery Pt.	7	63±4	5.9±0.8	27±13	6±2	ND	20±8
5 Penetanguishene WPCP	7	52±4	3.7±0.4	ND	5±3	ND	16±8
6 Not Available							
7 Midland - Downtown	7	59±4	4.8±1.1	164±42	9±1	ND	13±8
8 Midland - WPCP	4	66±7	6.6±0.8	55±25	19±19	ND	13±8
9 Wye River	7	62±5	6.1±0.8	ND	9±1	ND	14±8
10 Grandview Beach	7	63±5	6.6±0.6	24±18	13±5	1±1	
11 Port McNicoll	6	55±2	3.8±0.7	ND	7±2	1±1	22±8
12 Hog Bay - West Shore	7	52±3	3.8±0.6	59±30	4±2	ND	26±14
13 Methodist Island	7	52±3	3.1±0.4	ND	4±2	3±2	11±4
14 Victoria Harbour	4	50±3	4.0±1.2	ND	5±0	TR	17±10
15 Sturgeon River	7	72±3*	2.7±0.2	ND	6±2	ND	37±15
16 Sturgeon Bay	7	71±7*	5.7±0.8	ND	12±4	TR	27±10
17 Waubaushene	7	65±6	6.6±0.3	ND	10±3	1±1	11±4
18 Port Severn	7	67±3	2.6±0.1	ND	5±1	1±1	40±0

* Yearling fish

N = number
PCB = poly-chlorinated biphenyls
DDE = breakdown product of pesticide DDT
HCB = hexachlorobenzene

Appendix 2.6:
Severn Sound Fish Contaminant Inventory

Species and location	Year	N	Total Length(mm)	%Lipid	Mercury (ug/g) N/#detect	Mercury (ug/g) Range	PCB (ng/g) N/#detect	PCB (ng/g) Range	HCB (ng/g) N/#detect	HCB (ng/g) Range
Walleye:										
Severn Sound at North River	1989	10	58.7 – 74.8	–	10/10	0.47–1.40	–	–	–	–
Severn Sound at Port Severn	1989	8	47.2 – 73.6	–	8/8	0.15–1.30	–	–	–	–
Severn Sound at Port Severn	1977	16	42.0 – 78.2	–	16/16	0.26–1.60	–	–	–	–
Lake Huron	1976	7	49.0 – 60.5	–	7/7	0.31–1.00	–	–	–	–
Carp:										
Coldwater R., Severn Sound	1988	20	34.0 – 74.5	0.3 – 14.1	20/20	0.02–0.36	17/20	ND – 580	14/20	ND – 12
Coldwater R., Severn Sound	1982	20	35.5 – 87.0	2.7 – 17.0	20/20	0.04–0.52	16/16	83 – 3253	14/16	ND – 4
Pike:										
Georgian Bay, Severn Sound	1988	20	34.5 – 102.0	0.2 – 1.0	20/20	0.09–1.20	0/20	ND	0/20	ND
Black Crappie:										
Sturgeon Bay, Severn Sound	1980	20	20.5 – 34.3	–	20/20	0.02–0.43	0/5	ND	0/5	ND
Lake Huron, South Bay	1980	19	16.5 – 27.0	0.10 – 0.40	19/19	0.07–0.28	0/19	ND	0/19	ND
Sturgeon Bay, Severn Sound	1989	20	14.0 – 34.4	0.45 – 0.91	20/20	0.03–0.31	20/20	33 – 1590	1/20	ND–2
Smallmouth Bass:										
Sturgeon Bay, Severn Sound	1980	19	29.9 – 45.2	–	19/19	0.23–0.87	5/5	27 – 75	0/5	ND
Georgian Bay, Severn Sound	1987	20	22.0 – 46.2	0.56 – 1.36	20/20	0.13–0.82	1/20	ND – 60	5/20	ND – 30
Rainbow Trout:										
Coldwater R., Severn Sound	1989	18	37.2 – 71.5	2.66 – 9.07	18/18	0.02–0.38	18/18	38 – 1160	8/18	ND – 3
Yellow Perch:										
Sturgeon Bay, Severn Sound	1989	20	14.0 – 28.7	0.24 – 1.25	19/20	ND – 60	20/20	34 – 265	0/20	ND
Georgian Bay, Severn Sound	1987	18	14.5 – 24.1	0.56 – 0.96	18/18	0.03–0.23	0/18	ND	17/18	ND – 31
White Sucker:										
Sturgeon Bay, Severn Sound	1989	20	31.7 – 52.0	0.51 – 3.26	20/20	0.03–0.41	19/20	ND – 334	0/20	ND

Appendix 2.6:
Severn Sound Fish Contaminant Inventory

Species and location	OCS (ng/g) N/#detect	OCS (ng/g) Range	DDT (ng/g) N/#detect	DDT (ng/g) Range	Chlordane (ng/g) N/#detect	Chlordane (ng/g) Range	BHC (ng/g) N/#detect	BHC (ng/g) Range
Walleye:								
Severn Sound at North River	–	–	–	–	–	–	–	–
Severn Sound at Port Severn	–	–	–	–	–	–	–	–
Severn Sound at Port Severn	–	–	–	–	–	–	–	–
Lake Huron	–	–	–	–	–	–	–	–
Carp:								
Coldwater R., Severn Sound	17/20	ND – 30	12/20	ND – 200	4/20	ND – 19	4/20	ND – 5
Coldwater R., Severn Sound	11/14	ND – 79	16/16	11 – 1492	16/16	24 – 177	16/16	7 –58
Pike:								
Georgian Bay, Severn Sound	0/20	ND	5/20	ND – 5	0/20	ND	0/20	ND
Black Crappie:								
Sturgeon Bay, Severn Sound	–	–	5/20	ND – 3	0/20	ND	0/20	ND
Lake Huron, South Bay	–	–	12/19	ND – 5	0/19	ND	9/19	ND – 2
Sturgeon Bay, Severn Sound	0/20	ND	20/20	3 – 364	0/20	ND	0/20	ND
Smallmouth Bass:								
Sturgeon Bay, Severn Sound	–	–	4/8	ND – 25	2/8	ND – 6	2/8	ND – 1
Georgian Bay, Severn Sound	0/20	ND	13/20	ND –12	0/20	ND	0/20	ND
Rainbow Trout:								
Coldwater R., Severn Sound	1/18	ND – 2	18/18	6 – 413	11/18	ND – 19	0/18	ND
Yellow Perch:								
Sturgeon Bay, Severn Sound	0/20	ND	20/20	3 – 67	0/20	ND	0/20	ND
Georgian Bay, Severn Sound	0/18	ND	7/18	ND – 5	0/18	ND	0/18	ND
White Sucker:								
Sturgeon Bay, Severn Sound	0/20	ND	20/20	2 – 280	3/20	ND – 6	0/20	ND

Appendix 4.1: Assumptions for Calculations of Watershed Sources of Phosphorus

CURB Model:

Livestock Access:

total phosphorus	=	# of farms	X	kg/ defecation	X	prob. of def'n	X	# of waterings	X	days of access	X	% of day	X	# of animal units
		(survey)		(0.0012)		(0.18)		(2.5)		(180)		(survey)		(survey)

Milkhouse:

total phosphorus	=	# of farms	X	volume /day	X	#/litre
		(survey)		(survey)		(35)

Unacceptable Septic Systems:

total phosphorus	=	# of homes	X	people /house	X	kg/ cap·yr	X	%faulty
		(survey)		(3.1)		(0.8)		(20)

Source: UTRCA (1989) and Dillon et al (1986).

Appendix 4.2:

Severn Sound Phosphorus Supply Assumptions:

Sewage Plants:

1. Load was calculated by multiplying average monthly flow by average monthly concentration.
2. Load values for the period 1980-1990 for Penetanguishene Main and Fox street plants were corrected for errors in monitored flow and quality by increasing reported values by 50%.

Tributaries:

1. Flow was measured continuously at all stations.
2. Concentration were sampled on a flow weighted basis with approximately 100 samples taken per year.
3. load was calculated for high flow periods using a regression of flow vs. concentration.
4. Load for low flow periods was calculated by multiplying mean monthly flow by mean monthly concentration.
5. The division between low flow and high flow was defined individually for each tributary.
6. The model used to predict mean total phosphorus concentration over the ice-free period of the year is based on Dillon's work (Lakeshore Capacity Study, 1987).

$$[TP]_{IF} = L_T(1-R)/0.956\ q_s$$

where: $[TP]_{IF}$ = mean total phosphorus concentration
L_T = total phosphorus load
R = phosphorus retention coefficient
q_s = areal water load

Appendix 4.2 Cont'd:

Sample Calculation for Penetang Bay using 1984 information

1	Mean annual water elevation (WE) (m)	176.65
2	Volume (V) (x10^6 m3) *(WE-169.8181)/0.282146*	24.214
3	Surface Area (Ao) (m2)	3.704
4	Mean Depth (MD) (m) *(V/Ao)*	6.54
5	Rural Drainage Area (RDA)(km2)	39.37
6	Urban Drainage Area (UDA)(km2)	1.38
7	Total Drainage Area (TDA)(km2)*(RDA + UDA)*	40.75
8	Shoreline Development	
9	Residential units (res)	121
10	Seasonal units (cott)	56
11	Camp units (camp)	40
12	Motel units (mot)	
13	Vacant lots (vl)	59
14	Marina Development	
15	boat slips (bs)	1000
16	boat slip occupancy (%) (bso)	100
17	use in vicinity (%) (bsu)	50
18	Rural Export (Er) (kg/km2.yr) *(data)*	5.58
19	Urban Export (Eurb) (kg/km2.yr) *(Lpr*0.3*0.3*1000)*	92.76
20	Precip loading (Lpr) (kg/km2.yr) *(data)*	37.3
21	Precipitation (P) (m/yr)	1.031
22	Flows to Severn Sound (x10^6 m3/yr)	
23	Penetang area runoff (r-pen)(m/yr) *(data)*	0.154
24	Penetang area flow (Q-pen) *(RDA*r-pen)*	6.063
25	Urban flow (Q-urb) *(UDA*P)*	0.427
26	Sewage flows (x10^6 m3/d)	
27	Main St. WPCP (Fm)	2.87
28	Fox St. WPCP (Ff)	0.00
29	Total Sewage Flow (TSF) *(Fm+Ff)*	2.87
30	Sewage Effluent [TP] (mg/L)	
31	Main St. (Em)	0.54
32	Fox St. (Ef)	0
33	WPCP effluent flows (WF) (x10^6 m3/yr) *(TSF*365.25/1000)*	1.048
34	Total rural and urban flows (RUF) (x10^6 m3/yr) *(Q-pen + Q-urb)*	6.490
35	Total precipitation (Ptot) (x10^6 m3/yr) *(SA*P)*	3.818
36	Total outflow (TOV) (x10^6 m3/yr)*(WF+RUF+Ptot)*	11.356

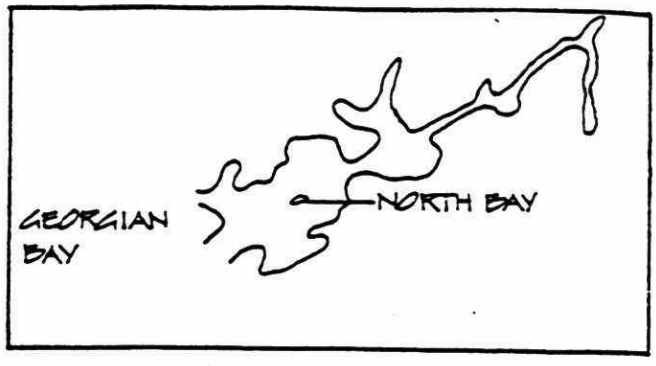
Appendix 4.2 Cont'd:

37	Flushing Rate (FR) (times per year) *(TOV/V)*	0.469
38	Areal Water Load (AWL) (m/yr) *(TOV/SA)*	3.066
39	Phosphorus Retention (RP) *(12.4/(12.4+AWL))*	0.802
40	Response Time (RT) (years) *(4*(1-RP)*ln2)*	1.172
	Supply	
41	Rural Drainage (JER) (kg/yr) *(Er*RDA)*	219.7
42	Urban Drainage (JEU) (kg/yr) *(Eurb*UDA)*	128.0
43	Precipitation (JPR) (kg/yr) *(Lpr*SA)*	138.2
44	Residences (JAres) (kg/yr) *(res*0.8*0.2*3.5)*	67.8
45	Cottages (JAcott) (kg/yr) *(cott*0.4)*	22.4
46	Campgr. units (JAcamp) (kg/yr) *(camp*0.2)*	8.0
47	Motel units (JAmot) (kg/yr) *(mot*0.4)*	0
48	Vacant lots (JAvl) (kg/yr) *(vl*0.8*0.2*3.5)*	33.0
49	TOTAL SHORE (JAshore) (kg/yr) *(JAres+JAcott+JAcamp+JAmot)*	98.3
50	Main St. STP (JAstpM) (kg/yr) *(Fm*Em*365.25*1.5)*	849.1
51	Fox St. STP (JAstpF) (kg/yr) *(Ff*Ef*365.25*1.5)*	0.0
52	TOTAL STP (JT) (kg/yr) *(JAstpF+JAstpM)*	849.1
53	Grey Water (JAgrey) (kg/yr) *(bs*bso/100*bsu/100*0.05)*	25.0
54	TOTAL (JT) *(JER+JEU+JPR+JAshore+JAstp+JAgrey)*	1458.1
55	SUPPLY TRANSFERRED *(JT*(1-RP))*	289.0
56	TOTAL LOADING (mg/m2*yr) *(JT/SA)*	393.7

Appendix 4.3: Nutrient Sensitivity calculations for North and South Bays, Severn Sound

WATER QUALITY ASSESSMENT

LOCATION
Lake: North Bay
Area Municipality: Georgian Bay
Latitude: 44^{o} 53'
Longitude: 79^{o} 48'



MORPHOMETRY

Surface area (m^2)	A_o	= 1.87×10^6
Volume (m^3)	V	= N.A.
Mean depth (m)	$\bar{z}$	= N.A.
Maximum depth (m)	z	= N.A.
Watershed area (m^2) (excluding lake)	A_d	= 9.02×10^6

LAND USE

No. cottages	N_c	= 91
No. resort units	N_r	= 200
No. approved but currently vacant lots	N_v	= 20
Crown land (%)		= N.A.
Patent land (%)		= N.A.
Date of MNR survey		= N.A.

HYDROLOGY

Mean annual precipitation (m/yr)	Pr	= 0.99
Mean annual evaporation (m/yr)	Ev	= 0.61
Mean annual runoff (m/yr)	r	= 0.483

Total outflow volume (m^3/yr):

If $A_d > 10A_o$

$Q = A_d \times r + Q_{\text{upstream lakes}}$

=

=

=

(continued)

Source: The District Municipality of Muskoka Planning and Economic Development Department

(HYDROLOGY continued)

If $A_d < 10A_o$

$$Q = A_d \times r + A_o (Pr-Ev) + Q_{\text{upstream lakes}}$$

$$= (9.02 \times 10^6)(0.483) + (1.87 \times 10^6)(0.99 - 0.61) + 0^*$$

$$= 5.07 \times 10^6$$

*no upstream lakes

Flushing rate (times/yr):

$$\rho = \frac{Q}{V}$$

$$= \text{N.A.}$$

Turnover time (yrs):

$$\tau = \frac{1}{\rho}$$

$$= \text{N.A.}$$

Areal water load (m/yr):

$$q_s = \frac{Q}{A_o}$$

$$= \frac{5.07 \times 10^6}{1.87 \times 10^6}$$

$$= 2.71$$

Retention time:

$$R = \frac{13.2}{13.2 + q_s}$$

$$= \frac{13.2}{13.2 + 2.71}$$

$$= 0.83$$

Appendix 4.3 Cont'd:

CONCLUSIONS:

There is reasonable agreement between the measured and predicted concentrations of summer chlorophyll a. Therefore, the predicted J_T of 348.8 kg/yr is used to predict J_{T_1} (kg/yr), the total phosphorus supply when all vacant lots are developed.

$$J_{T_1} = J_T + J_{A(vac)} + J_{U(vac)}$$
$$= 348.8 + 11.8 + 0$$
$$= 360.6$$

Then,

$$[P]_1 = \frac{360.6 \times 10^6 \ (1 - 0.83)}{5.07 \times 10^6}$$
$$= 12.1$$

$$\log \ [\text{chlor } a]_1 = 1.45 \ [\log 12.1] - 1.14$$

$$[\text{chlor } a]_1 = 2.7$$

$$SD_1 = (0.1138 + 0.0386 \ (2.7))^{-1}$$
$$= 4.6$$

Appendix 4.3 Cont'd:

WATER QUALITY ASSESSMENT

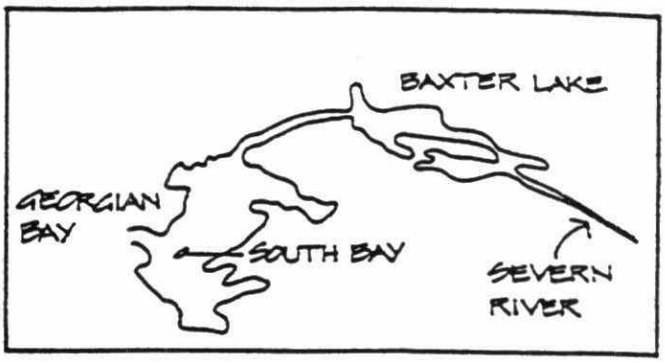
LOCATION

Lake: South Bay

Area Municipality: Georgian Bay

Latitude: 44^{o} 52'

Longitude: 79^{o} 46'



MORPHOMETRY

Surface area (m^2)	A_o	= 1.65×10^6
Volume (m^3)	V	= 4.33×10^6
Mean depth (m)	$\bar{z}$	= 2.9
Maximum depth (m)	z	= N.A.
Watershed area (m^2) (excluding lake)	A_d	= 8.54×10^6

LAND USE

No. cottages	N_c	= 106
No. resort units	N_r	= 6
No. approved but currently vacant lots	N_v	= 25
Crown land (%)		= N.A.
Patent land (%)		= N.A.
Date of MNR survey		= N.A.

HYDROLOGY

Mean annual precipitation (m/yr)	Pr	= 0.99
Mean annual evaporation (m/yr)	Ev	= 0.61
Mean annual runoff (m/yr)	r	= 0.483

Total outflow volume (m^3/yr):

If $A_d > 10A_o$

$Q = A_d \times r + Q_{upstream\ lakes}$

=

=

=

(continued)

Appendix 4.3 Cont'd:

(HYDROLOGY continued)

If $A_d < 10A_o$

$$Q = A_d \times r + A_o (Pr-Ev) + Q_{upstream\ lakes}$$

$$= (8.54 \times 10^6)(0.483) + (1.65 \times 10^6)(0.99 - 0.61) + Q_{Baxter}$$

$$= 4.75 \times 10^6 + 32.81 \times 10^6$$

$$= 37.56 \times 10^6$$

Flushing rate (times/yr):

$$\rho = \frac{Q}{V}$$

$$= \frac{37.56 \times 10^6}{4.33 \times 10^6}$$

$$= 8.67$$

Turnover time (yrs):

$$\tau = \frac{1}{\rho}$$

$$= \frac{1}{8.67}$$

$$= 0.12$$

Areal water load (m/yr):

$$q_s = \frac{Q}{A_o}$$

$$= \frac{37.65 \times 10^6}{1.65 \times 10^6}$$

$$= 22.76$$

Retention time:

$$R = \frac{13.2}{13.2 + q_s}$$

$$= \frac{13.2}{13.2 + 22.76}$$

$$= 0.37$$

CONCLUSIONS:

There is poor agreement between the mean measured and predicted concentrations of summer chlorophyll a. Therefore, the mean measured of 4.6 µg/L is used to estimate J_T.

$$\log [4.6] = 1.45 [\log P] - 1.14$$

$$[P] = 17.5$$

$$17.5 = \frac{J_T \times 10^6 (1 - 0.37)}{37.56 \times 10^6}$$

$$J_T = 1{,}043.3$$

Then, J_{T_1} (kg/yr), the total phosphorus supply when all vacant lots are developed, is:

$$J_{T_1} = J_T + J_{A(vac)} + J_{U(vac)}$$

$$= 1{,}043.3 + 14.8 + 80.8$$

$$= 1{,}138.9$$

and,

$$[P]_1 = \frac{1{,}138.9 \times 10^6 (1 - 0.37)}{37.56 \times 10^6}$$

$$= 19.1$$

$$\log [\text{chlor } a]_1 = 1.45 [\log 19.1] - 1.14$$

$$[\text{chlor } a]_1 = 5.2$$

$$SD_i = (0.1138 + 0.0386 (5.2))^{-1}$$

$$= 3.2$$

Appendix 4.4:

MARINA DOCKAGE IN SEVERN SOUND (1991)

MARINA NAME	EXISTING DOCKING	PROPOSED INCREASE*
PENETANG HARBOUR:		350
Northwest Basin	115	
Bay Marine	160	
Albert Cove Marina Ltd.	75	
Hindson's Marine Ltd.	350	
Beacon Bay Marina	200	
Bay Moorings	340	
Dutchman's Cove	150	
MIDLAND:		470
Sunnyside Marina (now Bayport Midland Marina Inc.)	230	
Wye Heritage Marina Inc.	1150	
Central Marina	80	
Midland Wye River	22	
Paradise Point Marina	40	
PORT McNICOLL:		
Duncan's Marina	125	
VICTORIA HARBOUR:		190
Queens Cove Marina	310	
STURGEON BAY:		
Caswells Beach	30	
Sturgeon Bay Ratepayers Association	30	
WAUBAUSHENE:		
Marshes Waubaushene Marina	100	
Pier 69	50	
Twin Bridges Marina	25	
PORT SEVERN:		
Lackies By The Bay	22	
Kovac's Boatel (closed 1992)	10	
HONEY HARBOUR:		350
Bayview Marine Resort	50	
Honey Harbour Boat Club	144	
Honey Harbour Small Motors	55	
Paragon Marina and Sports Inc.	185	
South Bay Cove Marina	140	
South Bay Yacht Club (Brandy's Island)	165	
Village Marina Ltd.	100	
TOTALS:	4435	1360

* includes expansions to existing marinas and new proposals.

Source: 1991 MNR, Midhurst District information

APPENDIX 4.5
SUMMARY OF PERMITS FOR SHORELINE WORK 1990 AND 1991

ACTIVITY	1990	%	1991	%
Dredging	41	38	20	25
Filling	2	2	2	2
Dock Construction	21	19	13	16
Beach Creation	1	1	0	0
Boat House	1	1	2	2
Shoreline Cleanup	7	6	4	5
Breakwall or Shorewall	15	14	13	16
Dock and Breakwall	2	2	0	0
Boat House and Dredging	1	1	2	2
Dock and Dredging	1	1	7	9
Breakwall and Boat ramp	2	2	1	1
Boat ramp or Marine Railway	7	6	5	6
Breakwall and Dredging	1	1	5	6
Shorewall/dredging/ dock	0	0	1	1
Miscellaneous	6	6	6	7
Total permits	108		81	

Source: MNR, Huronia District files for Tiny, Tay and Georgian Bay Townships, Jan.- Dec., 1990 and Jan.- Dec., 1991

Appendix 4.6: Draft Model Official Plan Amendment To Incorporate RAP Concerns and Requirements

NOTE: THIS DOCUMENT IS INTENDED FOR DISCUSSION WITH MUNICIPALITIES OF SEVERN SOUND AND SHOULD BE CONSIDERED A DRAFT

INTRODUCTION

Purpose

The amendment attempts to ensure that development is compatible with the objectives of the Severn Sound Remedial Action Plan.

Environmental Objectives

(a) To ensure that provisions are made for the protection of environmentally sensitive environments and the Severn Sound ecosystem.

(b) To ensure that provisions are made for the protection of the Severn Sound ecosystems in accordance with the objectives of the "Severn Sound Remedial Action Plan" including the:

  (i) protection of all remaining wetlands, critical fish habitats and other environmentally sensitive areas from the impacts of agriculture, urban development, shoreline alteration or other impacts that could threaten or destroy such areas; and

  (ii) improvement of water quality through remedial action and the maintenance of that enhanced quality level as development occurs by addressing potential development impacts such as nutrient, sediment, phosphorus, toxic and bacteria loadings.

(c) To conserve and manage natural resources to ensure a desirable urban environment and encourage the augmenting of these resources where appropriate.

(d) To encourage the appropriate agencies to enforce remedial action against sources of contamination and to encourage cooperation between the municipality and the appropriate agencies to ensure the environmental objectives of the Secondary Plan are met.

(e) To discourage incompatible development within areas prone to flooding or environmental hazards.

(f) To discourage development that would have the effect of aggravating existing flood, erosion or water quality situations.

Servicing Objectives

(a) To encourage the upgrading of deficient existing private sewage disposal systems on an individual basis where necessary;

(b) To ensure that new development utilizing private sewage disposal systems are designed to adequately protect the environment and health;

(c) To ensure effective and environmentally sound management of storm water drainage.

ENVIRONMENTAL PROTECTION

Environmental Protection designated lands include those lands that are environmentally sensitive areas or habitats including all wetlands and critical fish habitats or those lands that have inherent or natural environmental hazards such as flood susceptibility, poor drainage, erosion susceptibility, steep slopes or any other physical limitations to development. Flood prone lands...generally within thirty (30) metres of Severn Sound's high water mark may not be included as lands designated Environmental Protection, but shall be considered in accordance with the pertinent policies to further ensure the protection of the Severn Sound ecosystem.

Delineation, Setbacks and Buffers

A thirty (30) metre wide natural vegetation buffer shall be encouraged adjacent to the high water mark of the Severn Sound and shall be recognized in the implementing zoning by-law. Narrower natural vegetation buffers may be recognized in the implementing zoning by-law for those lands where existing development adjacent to the waterbody precludes the potential for the full thirty (30) metre wide buffer. The natural vegetation buffer area shall be maintained to protect the Severn Sound ecosystem and provide, among other things, the following possible environmental benefits:

(i) protect the waterbody by acting as a sediment and nutrient filter;

(ii) protect the shoreline by acting as an erosion control mechanism;

(iii) act as a temperature control system for the waterbody;

(iv) provide a potential habitat for fish-related food sources;

(v) provide protection for fish and its food sources from predators;

(vi) restrict human access to the waterbody; and

(vii) enhance the recreational and/or aesthetic value of the shoreline and waterbody.

A thirty (30) metre wide natural buffer shall also be encouraged adjacent to all existing water courses. The natural vegetation buffer should be comprised of permanent self-sustaining vegetation with plantings appropriate to provide adequate food, cover and shade. The municipality, in cooperation with the Ministry of Natural Resources and the Ministry of the Environment, shall endeavour to ensure the establishment and maintenance of the buffer by using, among other things, Section 34 of the Planning Act, agreements in accordance with Sections 40, 50 and 52 of the Planning Act or dedication to the municipality where appropriate.

STORM WATER MANAGEMENT

The municipality shall practice and encourage effective management of storm water drainage. It is the intent of the municipality that in the Secondary Plan area storm water will be managed to limit impact on the receiving water body.

Master Drainage Plans

It is the intent of the municipality that master drainage plans, detailing the handling of storm water drainage shall be prepared for each watershed, as delineated on Schedule "D". No development shall be permitted within a watershed prior to the completion and approval of a master drainage plan for the subject watershed. All drainage plans shall be approved by the municipality in consultation with the appropriate agencies. The drainage plan shall provide policies for the management of storm water quality and quantity in order to control flooding, erosion, sediment and pollution; and shall ensure that a coordinated approach is adopted for the planning and approval of development in accordance with sound storm water management principles.

The preparation of master drainage plans shall be in accordance with Provincial Guidelines and subject to consultation with the Ministry of Natural Resources, the Ministry of Environment and other appropriate agencies.

WILDLIFE HABITAT AND WETLANDS EVALUATION

The shoreline of Severn Sound in general, provides significant habitat (including spawning, nursery, feeding areas and migration routes) for a variety of cold and warm water fish

species waterfowl and other wildlife. This habitat and associated water quality shall be protected and managed to assist in ensuring the long range health of significant fish and wildlife communities.

Applications for development in the immediate proximity to the Severn Sound or areas designated as Environmental Protection on Schedule 'A' may be permitted in accordance with the policies of this Secondary Plan and subject to:

(a) review and consultation with the Ministry of Natural Resources to ensure protection of any significant fish or wildlife habitat, or wetland; and

(b) The consideration and implementation of techniques to ensure the impacts of development are minimized. Such techniques may include zoning (increased lot sizes, increased building setbacks); site plan control (retention of vegetation, the location of buildings and structures and utility corridors); and subdivision control or other agreements.

Appendix 4.7: Shoreline Construction Activities Permitted in the Severn Sound Nearshore

	RED	GREEN	YELLOW
Revetment - solid	No	Yes	Yes
Revetment - rip rap	Yes	Yes	Yes
Nearshore breakwater	No	Yes	Yes
Dredging small scale	No	Yes	Yes
Dredging large scale	No	Yes	Yes
Dredging maintenance	No	Yes	Yes
Fill beach	No	Yes	Yes
Fill property	No	No	No
Docks solid	No	No	No
Docks other	Yes	Yes	Yes
Groyne	No	No	No
Shorewall	Yes	Yes	Yes
Boathouse	Yes	Yes	Yes

No - not allowable

Yes - may be allowed through environmental review process

Appendix 4.8:

FISHERIES ACT POLICY

Environmental Assessment and Review Process Guidelines Order

The recent court decisions have ruled that the federal Environmental assessment and review process (EARP) must be applied to all activities where the Federal Government has decision making authority. Since authorizing the harmful alteration, disruption or destruction of fish habitat constitutes a decision by the federal Minister of Fisheries and Oceans, all projects which impact fish habitat must be reviewed in accordance with the Environmental Assessment and Review Process Guidelines Order (1984). The courts have also ruled that the Federal environmental assessment is required even though the project may have undergone provincial review.

The federal Environmental Assessment and Review Process (EARP) consists of two steps:

Step 1: Initial Assessment

Step 2: Full Public Review

The decision to move from Step 1 to Step 2 the public review stage is made by the initiating department on the basis of information obtained during the Initial Assessment stage of the review.

The Initial Assessment step of the process also consists of two stages a Screening and an Initial Environmental Evaluation. Decisions made during the Screening stage determine whether or not the Initial Environmental Evaluation will be necessary. Three possible decisions can be made at the Screening stage of the Initial Assessment.

1. The impacts are not significant or can be mitigated with known technology. The project can proceed through the normal regulatory process.

2. There is insufficient information to assess the magnitude of the impacts or the ability to mitigate is not known and additon information must be obtained. The project moves into the Initial Environmental Evaluation stage of Stage 1 and more information is obtained.

3. The impacts are significant and/or there is significant public concern. The project is referred to the Minister of environment for full public review by an independent panel.

Appendix 4.8 Cont'd:

If, as a result of a screening decision, an Initial Environmental Evaluation is required, additional information is provided by the proponent and evaluated by the initiating department with the assistance of other federal and provincial agencies. Material required to complete this stage of the assessment is normally obtained from consultants reports, specific studies, provincial E.A. documents and MOE, DOE, DFO, and OMNR technical and scientific staff.

On the basis of advise from other agencies and the additional information provided by the proponent, the initiating department makes one of the following decisions:

1. The impacts are not significant or can be mitigated with known technology. The project can proceed through the normal regulatory process.

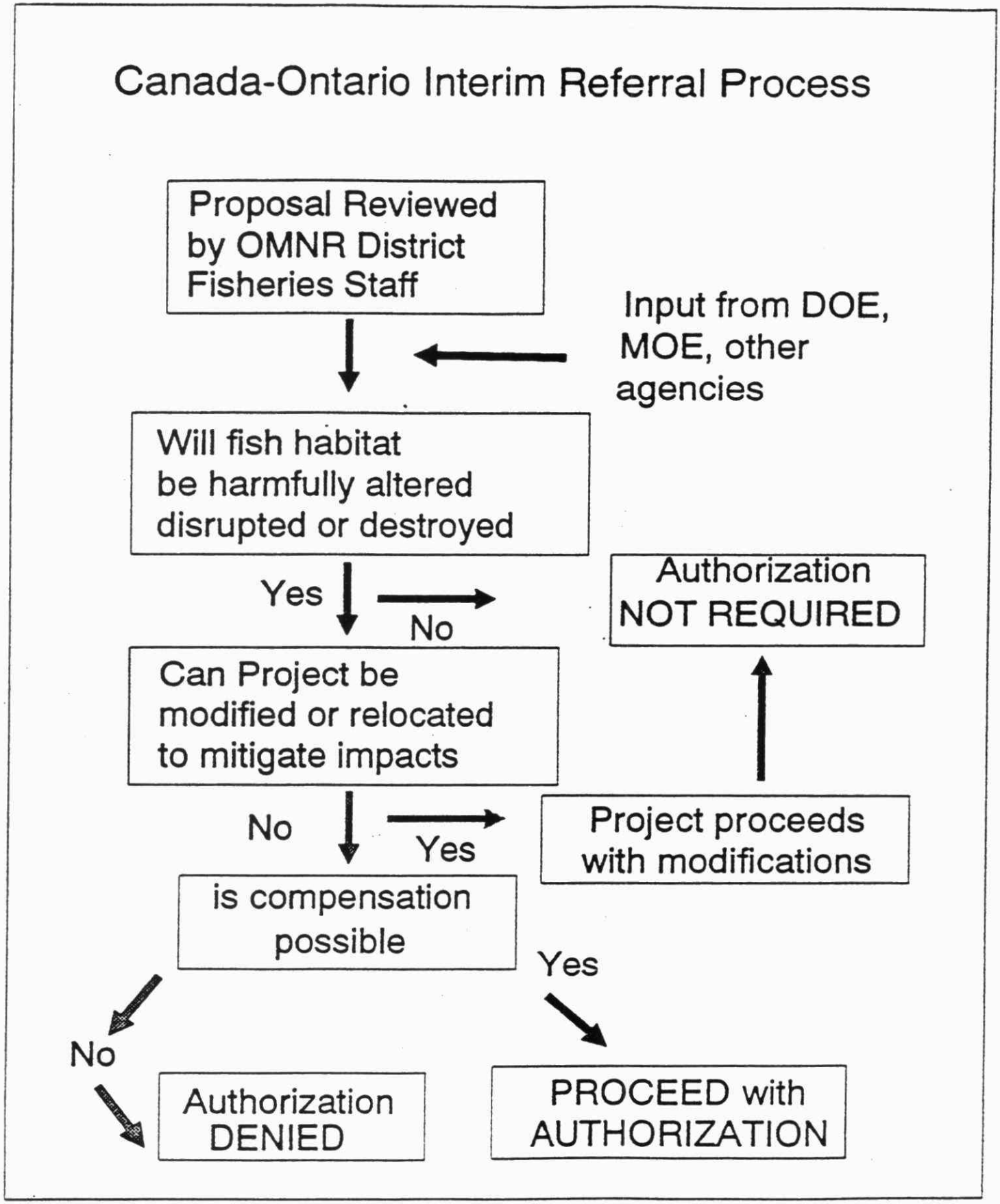
2. The impacts are significant. The project is either modified or stopped.

3. The impacts are significant and/or there is significant public concern. The project is referred to the Minister of the Environment for full public review by an independent panel.

In almost all cases projects can be addressed within E.A.R.P. with only minor modifications or specific remedial measures. In rare cases, where projects are apt to lead to unknown or potentially significant public concern E.A.R.P. requires that these proposals be referred to the Minister of Environment for full scale public review.

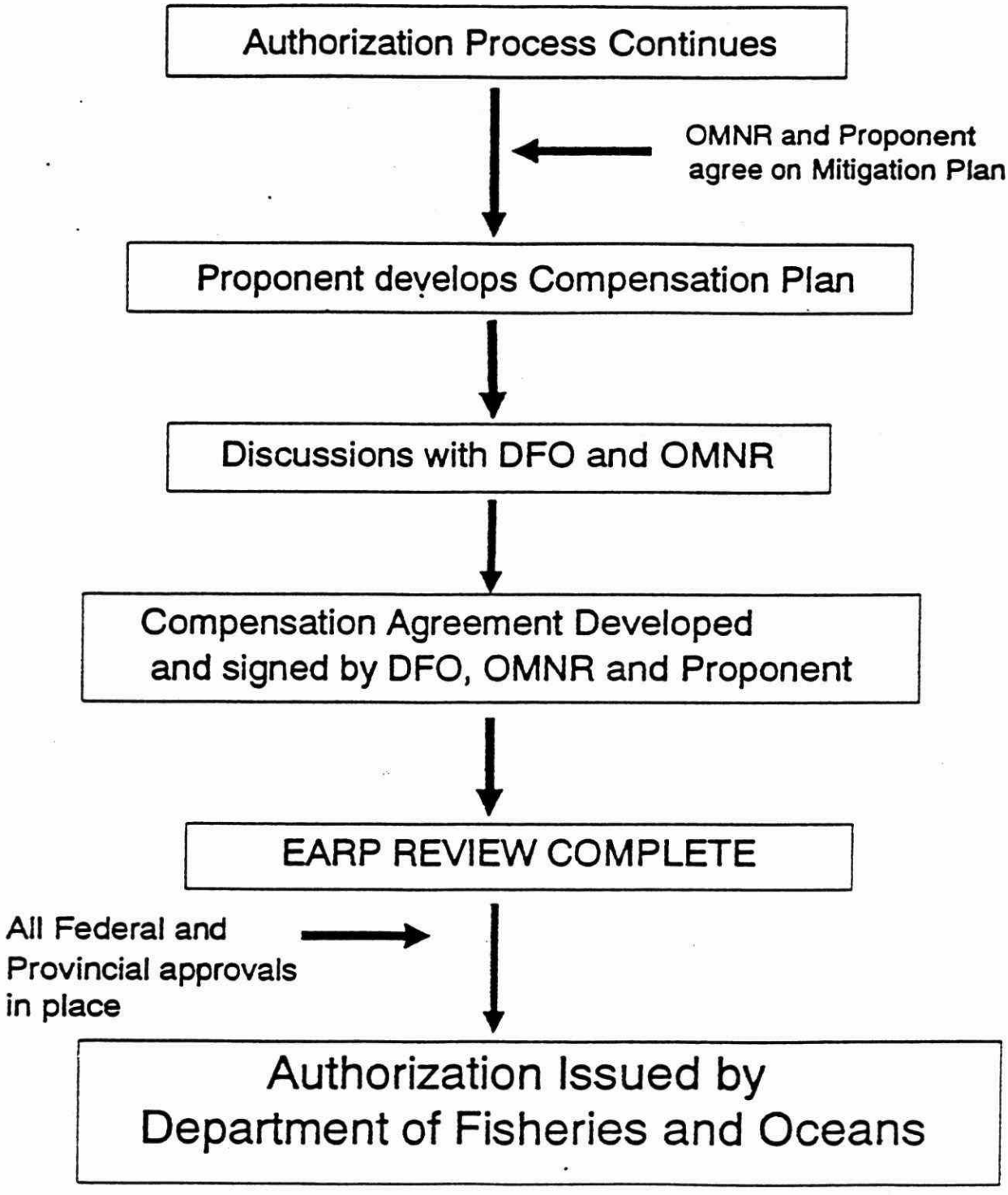
This decision has been interpreted to mean that projects requiring authorization under Section 35(2) of the Fisheries Act must be subject to an E.A.R.P. review before an Authorization can be issued.

[2 Charts of the Canada-Ontario Interim Referral Process]


Canada-Ontario Interim Referral Process
Proposal Reviewed by OMNR District Fisheries Staff
Input from DOE, MOE, other agencies
Will fish habitat be harmfully altered disrupted or destroyed
Yes
No
Authorization NOT REQUIRED
Can Project be modified or relocated to mitigate impacts
No
Yes
Project proceeds with modifications
is compensation possible
Yes
No
Authorization DENIED
PROCEED with AUTHORIZATION

Appendix 4.8 Cont'd:

Canada-Ontario Interim Referral Process


Authorization Process Continues
OMNR and Proponent agree on Mitigation Plan
Proponent develops Compensation Plan
Discussions with DFO and OMNR
Compensation Agreement Developed and signed by DFO, OMNR and Proponent
EARP REVIEW COMPLETE
All Federal and Provincial approvals in place
Authorization Issued by Department of Fisheries and Oceans

Appendix 5.1: Potential Cost Sharing Arrangements for Sewage Plant Upgrades

Estimated Cost of Upgrading STP's in the Severn Sound RAP AOC's

SCENARIO		Midland	Coldwater	Elmvale	Penetang.	Port McNicoll	Victoria Harbour
1 Initial Modifications	Total annual cost	$124,300	$17,580	$25,880	N/A	N/A	N/A
	Population	13,114	1,254	1,681			
	Responsibility	Capital O&M	CapitalO&M	CapitalO&M			
	Federal	$0 $0	$0 $0	$0 $0			
	Provincial	$0 $0	$7.0 $0	$6.9 $0			
	Municipal	$0 $124.3	$1.4 $9.2	$1.8 $17.2			
2 0.3mg/LTP	Total annual cost	$427,100	$73,220	$161,340	$272,000	$75,100	N/A
	Population	13,114	1,254	1,681	6,643	2,000	
	Responsibility	Capital O&M	CapitalO&M	CapitalO&M	Capital O&M	Capital O&M	
	Federal	$0 $0	$0 $0	$0 $0	$0 $0	$0 $0	
	Provincial	$87.6 $0	$46.5 $0	$90.3 $0	$81.9 $0	$52.8 $0	
	Municipal	$175.2 $164.3	$9.5 $17.2	$23.2 $47.8	$123.7 $66.4	$15.8 $6.5	
3 0.15mg/LTP	Total annual cost	$495,400	$77,120	$210,800	$355,700	$83,500	$1,510
	Population	13,114	1,254	1,681	6,643	2,000	2,000
	Responsibility	Capital O&M	CapitalO&M	CapitalO&M	Capital O&M	Capital O&M	CapitalO&M
	Federal	$0 $0	$0 $0	$0 $0	$0 $0	$0 $0	$0 $0
	Provincial	$88.7 $0	$47.4 $0	$110.8 $0	$103.9 $0	$53.5 $0	$0.9 $0
	Municipal	$177.5 $229.2	$9.7 $20	$28.5 $71.5	$156.7 $95.2	$16 $14	$0.3 $0.25
4 0.10 mg/LTP	Total annual cost	$914,000	$177,460	$304,100	$794,000	$198, 830	$23,100
	Population	13,114	1,254	1,681	6,643	2,000	2,000
	Responsibility	Capital O&M	CapitalO&M	CapitalO&M	CapitalO&M	Capital O&M	CapitalO&M
	Federal	$0 $0	$0 $0	$0 $0	$0 $0	$0 $0	$0 $0
	Provincial	$203.7 $0	$137.0 $0	$176.3 $0	$260.4 $0	$135.4 $0	$15.1 $0
	Municipal	$407.4 $302.9	$28.1 $26.7	$45.3 $82.5	$392.9 140.8	$40.5 $22.8	$4.5 $3.5

NOTES:

* Source of all initial cost estimates XCG Consultants Ltd., (1991) A Review of the Performance and Upgrading Alternatives for Water Pollution Control Plants Discharging to Severn Sound.
* All Capital and O&M costs are in thousands of dollars.
* All values are amortized over a 10 year period.
* *FOR POPULATIONS LESS THAN 7500*

Local water distribution or sewage collection works along with sewage treatment or water supply facilities grants are calculated in accordance with the formula. Maximum grant = 85 percnt where p=1,000 or less

GRANT (% OF NET COST)=93.00 - (P x 0.008)

P = Population of the municipality or community per assessment rolls.

* *FOR POPULATIONS GREATER THAN 7500*

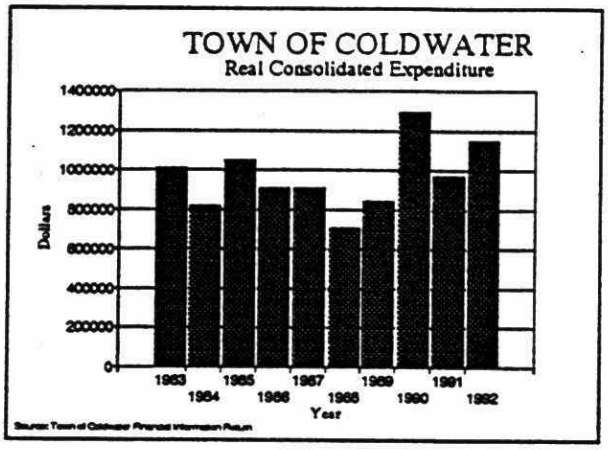
Environmental upgrade grants will be based on 33 percent of the cost and growth related upgrade grants will be based on 15 percent of the cost.

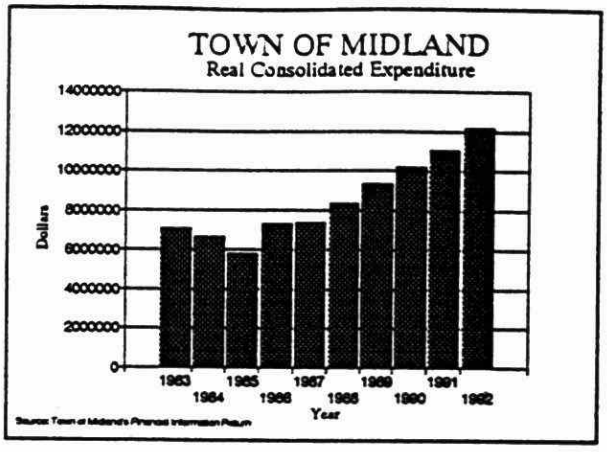
* These cost-sharing estimates are not definative. The intention is to provide some indication of possible allocation of costs.

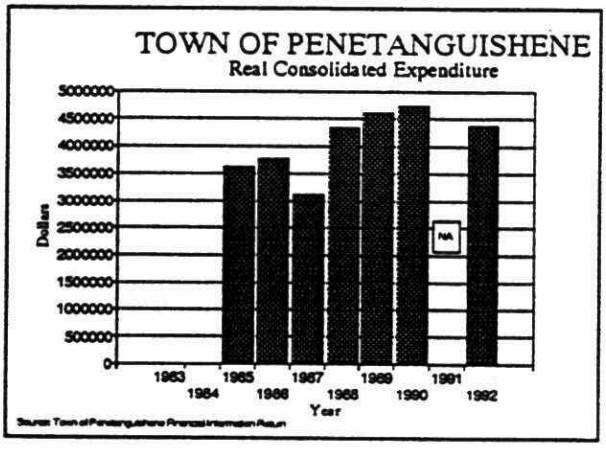
Illustration (how to read table):

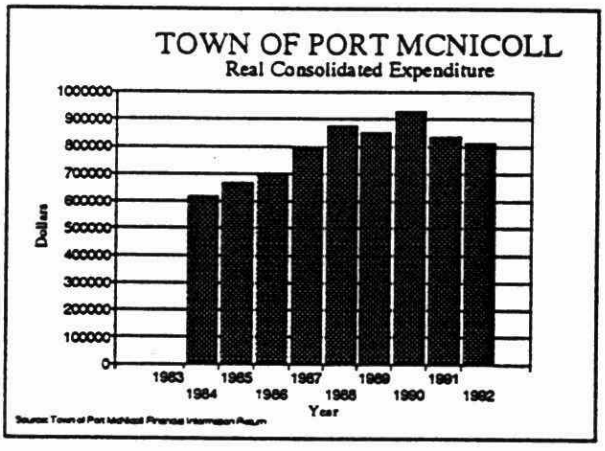
If Penetanguishene moves to effluent concentrations of less than 0.1mg/LTP, the total annual cost for 10 years would be approximately $794,000. Of this total, $140,000 would be for enhanced operation and maintenance. Typically, additional O&M requirements are not eligible for Provincial assistance, and therefore is listed as a municipal cost. The remaining $653,000 ($794,000 - $140,000) capital cost is eligible for assistance under an existing provincial program - the precise amount of which is based on the population level. The Provincial formula indicates that provincial funding for 40 per cent or $260,400 could be provided, for the capital component. The remaing $392,900 would typically be provided by the municipality. Consequently the total annual cost to the town of Penetanguishene in this illustration, would be $533,700 (capital + O&M).

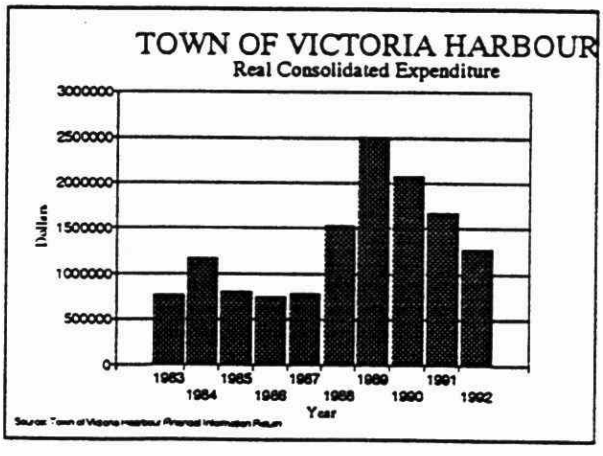
Appendix 5.2: Municipal Consolidated Expenditure for Severn Sound Nearshore





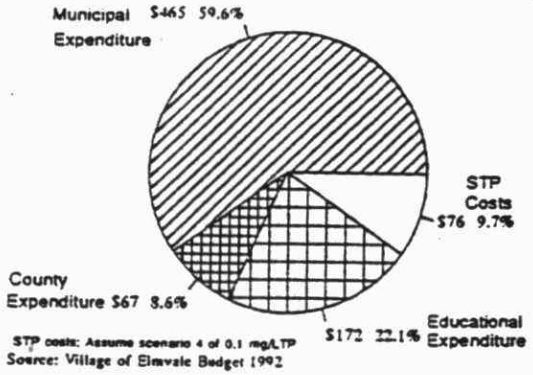






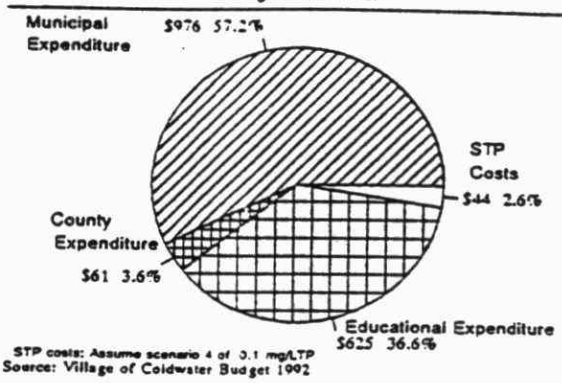
Appendix 5.2 Cont'd:

STP Costs in Relation to Municipal Per Capita Expenditures
Village of Elmvale



STP costs: Assume scenario 4 of 0.1 mg/LTP
Source: Village of Elmvale Budget 1992

STP Costs in Relation to Municipal Per Capita Expenditures
Village of Coldwater

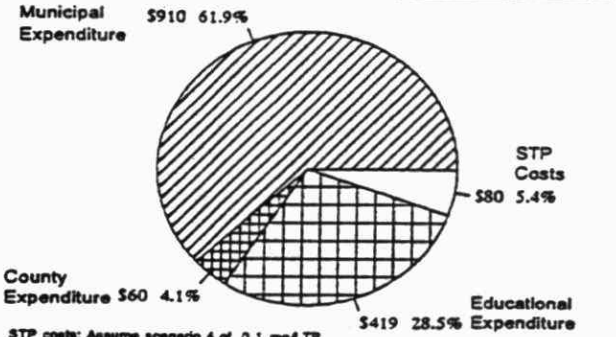


STP costs: Assume scenario 4 of 0.1 mg/LTP
Source: Village of Coldwater Budget 1992

STP Costs in Relation to Municipal Per Capita Expenditures
Village of Victoria Harbour

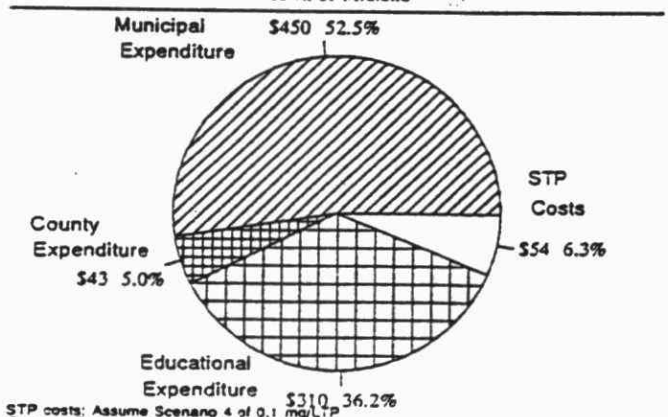
STP costs: Scenario 4 of 0.10mg/LTP
Source: Village of Victoria Harbour Budget 1992

STP Costs in Relation to Municipal Per Capita Expenditures
Town of Penetanguishene



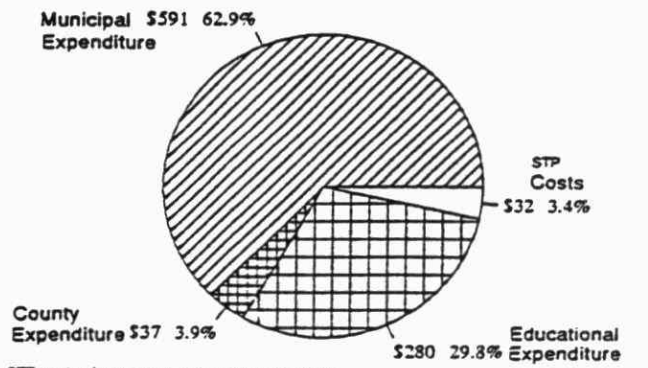
STP costs: Assume scenario 4 of 0.1 mg/LTP
Source: Town of Penetanguishene Budget 1992

STP Costs in Relation to Municipal Per Capita Expenditures
Town of Midland



STP costs: Assume Scenario 4 of 0.1 mg/LTP
Source: Town of Midland Budget 1992

STP Costs in Relation to Municipal Per Capita Expenditures
Village of Port McNicoll



STP costs: Assume scenario 4 of 0.1 mg/LTP
Source: Village of Port McNicoll Budget 1992

Appendix 5.3: Agricultural Costs and Cost Effectiveness for Four Sources in Six Severn Sound Watersheds

Cost Effectiveness Analysis for Abatement of Identified Sources within the Sturgeon Watershed

Source	Remedial Practice	Average Economic Life (years)	Capital Cost ($)	Amortized Cost ($/yr)	Maintenance Cost ($/yr)	Operation Cost ($/yr)	Total Annual Cost	Total Watershed Annual Cost	Annual Cost/Effectiveness
									Total Phosphorus ($/kg)
Livestock Access	1. Fence one side + alt. water	5	4500	900	225		1125	4500	106.00
	2. Fence both sides + restrict access	5	9000	1800	450		2250	9000	212.00
		20	10000	500	500		1000	10000	94.00
Milkhouse Washwater	1.Treatment trench	5	2750	550		115	665	2660	19.00
	2. Concrete tank + land application	20	3780	189		290	479	1916	13.69
Septic System	1. Tank + weeping bed	10	5000	500		35	535	936	115.00
Manure Runoff	1. Liquid lagoon + fence	20	5500	275		2400	2675	2675	563.00
	2. Solid + concrete tank	20	25200	1260		690	1950	1950	333.00
	3. Solid + lagoon	20	19800	990		810	1800	1800	254.00

Appendix 5.3 Cont'd:

Cost Effectiveness Analysis for Abatement of Identified Sources within the Wye Watershed

Source	Remedial Practice	Average Economic Life (years)	Capital Cost ($)	Amortized Cost ($/yr)	Maintenance Cost ($/yr)	Operation Cost ($/yr)	Total Annual Cost	Total Watershed Annual Cost	Annual Cost/Effectiveness
									Total Phosphorus ($/kg)
Livestock Access	1. Fence one side + alt. water	5	4500	900	225		1125	14625	341.00
	2. Fence both sides + restrict access	5	9000	1800	450		2250	29250	682.00
		20	10000	500	500		1000	32500	303.00
Milkhouse Washwater	1.Treatment trench	5	2750	550		115	665	11970	19.00
	2. Concrete tank + land application	20	3780	189		290	479	8622	13.69
Septic System	1. Tank + weeping bed	10	5000	500		35	535	4949	115.00
Manure Runoff	1. Liquid lagoon + fence	20	5500	275		2400	2675	93625	563.00
	2. Solid + concrete tank	20	25200	1260		690	1950	68250	333.00
	3. Solid + lagoon	20	19800	990		810	1800	63000	254.00

Appendix 5.3 Cont'd:

Cost Effectiveness Analysis for Abatement of Identified Sources within the Hog Watershed

Source	Remedial Practice	Average Economic Life (years)	Capital Cost ($)	Amortized Cost ($/yr)	Maintenance Cost ($/yr)	Operation Cost ($/yr)	Total Annual Cost	Total Watershed Annual Cost	Annual Cost/Effectiveness
									Total Phosphorus ($/kg)
Livestock Access	1. Fence one side + alt. water	5	4500	900	225		1125	12375	178.00
	2. Fence both sides + restrict access	5	9000	1800	450		2250	24750	357.00
		20	10000	500	500		1000	27500	159.00
Milkhouse Washwater	1.Treatment trench	5	2750	550		115	665	3990	14.25
	2. Concrete tank + land application	20	3780	189		290	479	2874	10.26
Septic System	1. Tank + weeping bed	10	5000	500		35	535	11235	115.00
Manure Runoff	1. Liquid lagoon + fence	20	5500	275		2400	2675	50825	563.00
	2. Solid + concrete tank	20	25200	1260		690	1950	37050	333.00
	3. Solid + lagoon	20	19800	990		810	1800	34200	254.00

Appendix 5.3 Cont'd:

Cost Effectiveness Analysis for Abatement of Identified Sources within the Coldwater Watershed

Source	Remedial Practice	Average Economic Life (years)	Capital Cost ($)	Amortized Cost ($/yr)	Maintenance Cost ($/yr)	Operation Cost ($/yr)	Total Annual Cost	Total Watershed Annual Cost	Annual Cost/Effectiveness
									Total Phosphorus ($/kg)
Livestock Access	1. Fence one side + alt. water	5	4500	900	225		1125	10125	109.08
	2. Fence both sides + restrict access	5	9000	1800	450		2250	20250	218.00
		20	10000	500	500		1000	22500	435.00
Milkhouse Washwater	1.Treatment trench	5	2750	550		115	665	3225	19.00
	2. Concrete tank + land application	20	3780	189		290	479	2395	13.69
Septic System	1. Tank + weeping bed	10	5000	500		35	535	2942	115.00
Manure Runoff	1. Liquid lagoon + fence	20	5500	275		2400	2675	42800	563.00
	2. Solid + concrete tank	20	25200	1260		690	1950	31200	333.00
	3. Solid + lagoon	20	19800	990		810	1800	28800	254.00

Appendix 5.3 Cont'd:

Cost Effectiveness Analysis for Abatement of Identified Sources within the Copeland Watershed

Source	Remedial Practice	Average Economic Life (years)	Capital Cost ($)	Amortized Cost ($/yr)	Maintenance Cost ($/yr)	Operation Cost ($/yr)	Total Annual Cost	Total Watershed Annual Cost	Annual Cost/Effectiveness
									Total Phosphorus ($/kg)
Livestock Access	1. Fence one side + alt. water	5	4500	900	225		1125	1125	178.00
	2. Fence both sides + restrict access	5	9000	1800	450		2250	2250	357.00
		20	10000	500	500		1000	2500	159.00
Milkhouse Washwater	1.Treatment trench	5	2750	550		115	665	3990	14.25
	2. Concrete tank + land application	20	3780	189		290	479	2874	10.26
Septic System	1. Tank + weeping bed	10	5000	500		35	535	535	115.00
Manure Runoff	1. Liquid lagoon + fence	20	5500	275		2400	2675	10700	563.00
	2. Solid + concrete tank	20	25200	1260		690	1950	7800	333.00
	3. Solid + lagoon	20	19800	990		810	1800	7200	254.00

Appendix 5.3 Cont'd:

Cost Effectiveness Analysis for Abatement of Identified Sources within the North Watershed

Source	Remedial Practice	Average Economic Life (years)	Capital Cost ($)	Amortized Cost ($/yr)	Maintenance Cost ($/yr)	Operation Cost ($/yr)	Total Annual Cost	Total Watershed Annual Cost	Annual Cost/Effectiveness
									Total Phosphorus ($/kg)
Livestock Access	1. Fence one side + alt. water	5	4500	900	225		1125	58500	489.00
	2. Fence both sides + restrict access	5	9000	1800	450		2250	117000	978.00
		20	10000	500	500		1000	130000	435.00
Milkhouse Washwater	1.Treatment trench	5	2750	550		115	665	5895	19.00
	2. Concrete tank + land application	20	3780	189		290	479	4311	13.69
Septic System	1. Tank + weeping bed	10	5000	500		35	535	7223	115.00
Manure Runoff	1. Liquid lagoon + fence	20	5500	275		2400	2675	144450	563.00
	2. Solid + concrete tank	20	25200	1260		690	1950	105300	333.00
	3. Solid + lagoon	20	19800	990		810	1800	97200	254.00

APPENDIX 7.1: MAJOR EVENTS OF THE PUBLIC INVOLVEMENT PROCESS

September 1987 - Establishement of Public Consultation Framework

May 1988 - Initiation of Phase I Public Involvement Program

May 1988 - Release of Draft Stage I Document for Public Review

Summer, 1988 - Distribution of Newsletter #1

June 20, 1988 - Municipal Information Workshop

This workshop was held to inform municipal officials of the RAP and the water quality concerns of Severn Sound. Twelve people were present representing the Townships of Tay, Tiny, Port McNicoll, Georgian Bay and the Ministry of the Environment, Barrie.

October 13 & 15, 1988 - Public Meetings

The main purpose of these meetings was to inform the public of the water quality of Severn Sound and of the RAP process. It was also to obtain feedback from citizens on their perceived uses, goals and priorities for remedial action so that Stage II of the plan could begin. Attendance for both meetings totalled 155.

February, 1989 - Formation of the PAC

February , 1989 - Severn Sound RAP Participation at Wye Heritage Marina Workshop

This workshop was hosted by the Wye Heritage Marina to assist marina operators with environmental problems. Representatives from nine marinas and the Severn Sound RAP were present. Experts from the government and industry led discussions on grey water legislation, antifreeze use and overwintering procedures, antifouling paints, enforcement, marine construction and marina products.

Spring/Summer, 1989 - Discussions and Information distribution of Water Use Goals

Summer, 1989 - Distribution of Newsletter #2

June, 1990 - Formation of PAC Subcommittee

A subcommittee of PAC members was formed to discuss the format and final content of the Remedial Options Discussion Paper.

June 12, 1990 - Press Conference

This conference was held to announce the release of the Remedial Options Discussion Paper. All in attendance received the press release and a copy of the discussion paper. Immediate local coverage of the event appeared in print, radio and TV and reporters at the conference represented a majority of the media in the area.

July 1990 - Presentations

PAC members gave a RAP talk and slide show to more than 20 organizations that included service clubs, ratepayers' associations and council meetings.

October 11 & 13, 1990 - Public Meetings

These meetings were held to obtain feedback on the RODP. They were attended by 97 people. After a slide presentation and question period, people could view the displays of RAP Team research, marina products and the Midland Sewage Treatment Plant.

November 8, 1990 - Public Meeting, Town of Penetanguishene

Citizens were given an opportunity to attend this meeting held to outline the town's phosphorus reduction strategy based on a Severn Sound RAP study. The RAP Coordinator was on hand to answer any questions.

Spring, 1991 - Distribution of Newsletter #3

August 13, 1991 - DO Day

Dissolved Oxygen Day (DO Day) was an event held to measure bottom water dissolved oxygen concentrations at 40 locations throughout the Severn Sound. The public was invited to observe scientific equipment, procedures and information displays and to meet with RAP Team members. Public involvement included the local media, Midland Parks and Recreation and local residents.

October 5 & 6, 1991 - Severn Sound RAP Participation at the Georgian Bay Association Conference

More than 150 delegates attended the conference to address such issues as water quality, wildlife, fishing, recreation, planning, boat traffic, policing and grey water. This event included presentation and participation in discussions by the RAP Coordinator and the staffing of the RAP display on both days.

Spring, 1992 - Distribution of Newsletter #4

April 23, 1992 - Municipal Workshop

The main purpose of the workshop was to introduce and discuss draft sections of the Stage 2 Document. Municipal staff such as planners, engineers, sewage treatment plant operators and clerks as well as agricultural representatives were targeted. A total of 47 people attended, 12 more than the expected 35. Of the 14 municipalities in Severn Sound, 12 were represented. Questions and answers were recorded that resulted in several follow-up action items.

April 24 to May 9, 1992 - Tree Planting for the Tributary Rehabilitation Program

During this time, seven tree planting events were held on several farms in Severn Sound. Over 13,400 trees were planted along the Hog, North and Wye Rivers with the help of: Elmvale District H.S., Midland Big Brothers, Elmvale Junior Farmers, Barrie Big Brothers, Orillia Fish & Game Conservation Club, Orillia Collegiate and Vocational Inst., Park Street Collegiate Inst., Midland Area Boy Scouts and Trout Unlimited Canada.

May 2, 1992 - Tree Planting Competition

The RAP Team officially challenged PAC members, friends and family to plant as many trees as possible at a chosen site along the Hog River. This event was arranged as part of the Severn Sound RAP Tributary Rehabilitation Program. Approximately 5 children and 20 adults planted close to 1,600 trees during stormy weather conditions.

June 11, 1992 - Municipal Heads of Council Meeting

A meeting of Municipal Reeves, Mayors, Councillors and other representatives was organized by the Mayor of Midland as a follow-up to the Municipal Workshop to further discuss the Draft Stage II Document and the Severn Sound municipalities roles in implementation. Total attendance numbered 18. Of the 14 municipalities in Severn Sound, 12 were represented.